U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-291 966

Report to Congress on Control of Combined Sewer Overflow in the United States

CH2M Hill Southeast, Inc, Gainesville, FL

Prepared for

Environmental Protection Agency, Washington, DC Municipal Construction Div

1 Oct 78

United States
Environmental Protection
Agency

Office of Water
Program Operations (WH-547)
Washington DC 20460

October 1978
EPA-430/9-78-006

PB 291966

Water

EPA

Report To Congress On Control Of Combined Sewer Overflow In The United States

MCD - 50

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

DISTRIBUTION STATEMENT

To order this publication, "Report to Congress on Control of Combined Sewer Overflow in the United States" (MCD-50) from EPA, write to:

General Services Administration (8FFS)
Centralized Mailing Lists Services
Building 41, Denver Federal Center
Denver, Colorado 80225

Please indicate the MCD number and title of publication.

Multiple copies may be purchased from:

National Technical Information Service
Springfield, Virginia 22151

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 430/9-78-006	2.	3. RECIPIENT'S ACCESSION NO. PB291966
4. TITLE AND SUBTITLE Report to Congress on Control of Combined Sewer Overflow in the United States		5. REPORT DATE October 1978
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Ronald L. Wycoff James E Scholl and Michael J. Mara		8. PERFORMING ORGANIZATION REPORT NO. MCD-50
9. PERFORMING ORGANIZATION NAME AND ADDRESS CH2M HILL SOUTHEAST, INC. (Formerly Black, Crow & Eidsness Inc.) 7201 N W. 11th Place Gainesville, FL 32602		10. PROGRAM ELEMENT NO. 2BG647
		11. CONTRACT/GRANT NO. 68-01-3993
12. SPONSORING AGENCY NAME AND ADDRESS U S Environmental Protection Agency Municipal Construction Division Office of Water Program Operations Washington DC 20460		13. TYPE OF REPORT AND PERIOD COVERED Final
		14. SPONSORING AGENCY CODE 700/02

15. SUPPLEMENTARY NOTES

Project Officer Philip H. Graham

16. ABSTRACT

Section 516 (c) of the 1977 Clean Water Act provides that

> "(c) The Administrator shall submit to the Congress by October 1, 1978, a report on the status of combined sewer overflows in municipal treatment works operations The report shall include (1) the status of any project funded under the Act to address combined sewer overflows, (2) a listing by State of combined sewer overflow needs identified in the 1977 state priority listings, (3) an estimate for each applicable municipality of the number of years necessary, assuming an annual authorization and appropriation for the construction grants program of $5,000,000,000 to correct combined sewer overflow problems (4) an analysis using representative municipalities faced with major combined sewer overflow needs of the annual discharges of pollutants from overflows in comparison to treated effluent discharges, (5) an analysis of technological alternatives available to municipalities to correct major combined sewer overflow problems, and (6) any recommendations of the Administrator for legislation to address the problem of combined sewer overflows, including whether a separate authorization and grant program should be established by the Congress to address combined sewer overflows."

This report, "Control of Combined Sewer Overflow in the United States," responds to the above mandate.

KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Combined Sewers Construction Grants Water Pollution Control Cost Effectiveness Rainfall Runoff Water Quality	Drainage Systems Storm Runoff Urban Hydrology Combined Sewer Overflow	

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 226
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE PC A11 MF A01

EPA Form 2220-1 (9-73)

REPORT TO CONGRESS
ON
CONTROL OF COMBINED SEWER OVERFLOW
IN THE
UNITED STATES

Project Officer

Philip H. Graham
Facility Requirements Division
Office of Water Program Operations
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Contract No. 68-01-3993
EPA Report No. 430/9-78-006
MCD Report No. 50

October 1, 1978

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 29 1978

THE ADMINISTRATOR

Honorable Walter F. Mondale
President of the Senate
Washington, D.C. 20510

Dear Mr. President:

Enclosed is the Environmental Protection Agency's (EPA's) report, "Control of Combined Sewer Overflow in the United States," required October 1, 1978, by section 516(c) of the Clean Water Act. This report presents by State the status of awarded grants, requested grants, and the estimated time required to achieve required control of combined sewer overflow pollution. It also compares discharges of pollutants from treated municipal effluent with combined sewer overflow and analyzes alternative control technologies. Finally, it presents legislative alternatives to control pollution from combined sewer overflow.

Combined sewers have been identified in about 1,300 communities, and serve a population of 37,606,000 in an area of 2,248,000 acres. The 58 communities with greater than 10,000 acres of combined sewer area account for 83 percent of the area and 81 percent of the population served by combined sewers, and are distributed among 24 States.

Combined sewer systems are located in some of the most heavily populated urban centers of our nation. Pollutant discharges are limited to generally short reaches of receiving waters located near highly concentrated population. Many millions of people observe and are exposed to the receiving water impacts resulting from combined sewer overflow.

Grants for combined sewer overflow control have been awarded for 6.4 percent and requested for 16.8 percent of the total combined sewer overflow control needs of an estimated $21.16 billion. Thus, grants have been made or requested for a total of 24.2 percent of the estimated needs.

The time required to provide needed funds to correct combined sewer overflow problems varies widely among the States. The most sensitive variables affecting this time are Federal allocation of construction grant funds to the States, State allocation of funds to combined sewer overflow control, and annual rate of construction cost increase.

If the annual construction cost increase is matched by an increase in Federal and State funding for combined sewers, average time to fund correction for all States ranges between 8 and 14 years for the alternative allocation funding formulae assumed in the report. The maximum time for any State ranges from 14 to 40 years depending on the assumptions.

A comparison of the pollutant loads from only the national combined sewer area shows that more than 80 percent of the total annual lead and suspended solids loads are delivered to the receiving waters from combined sewer overflows. More than 80 percent of the annual nutrient (phosphorus and nitrogen) loads are delivered to the receiving waters from secondary wastewater treatment plant effluent. Annual BOD_5, (biochemical oxygen demand) loads are split evenly between secondary wastewater treatment plants' effluent and combined sewer overflow.

Five legislative alternatives are analyzed in the report. EPA recommends the first alternative, to continue with the present law. The success of this alternative in providing timely funding for control of combined sewer overflow will depend principally on the amount of money available to States with serious combined sewer problems, the proportion of these funds assigned by the States to combined sewer projects, and the annual rate of increase in construction costs.

We have based this report on the best available information, including unpublished data we are gathering in the current "needs" survey for the next report to Congress on the cost of needed publicly-owned treatment works. The "needs" survey results, due February 10, 1979, will permit us to refine the conclusions and recommendation in this report. The "needs" survey results will, for example, provide a revised estimate by State of the cost of controlling combined sewer overflow, and an analysis of the impact of pollutant loads for combined sewers on receiving waters.

I would be pleased to discuss further the recommendations made in this report at your convenience.

Sincerely yours,

Douglas M. Costle

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 29 1978

THE ADMINISTRATOR

Honorable Thomas P. O'Neill, Jr.
Speaker of the House
of Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

Enclosed is the Environmental Protection Agency's (EPA's) report, "Control of Combined Sewer Overflow in the United States," required October 1, 1978, by section 516(c) of the Clean Water Act. This report presents by State the status of awarded grants, requested grants, and the estimated time required to achieve required control of combined sewer overflow pollution. It also compares discharges of pollutants from treated municipal effluent with combined sewer overflow and analyzes alternative control technologies. Finally, it presents legislative alternatives to control pollution from combined sewer overflow.

Combined sewers have been identified in about 1,300 communities, and serve a population of 37,606,000 in an area of 2,248,000 acres. The 58 communities with greater than 10,000 acres of combined sewer area account for 83 percent of the area and 81 percent of the population served by combined sewers, and are distributed among 24 States.

Combined sewer systems are located in some of the most heavily populated urban centers of our nation. Pollutant discharges are limited to generally short reaches of receiving waters located near highly concentrated population. Many millions of people observe and are exposed to the receiving water impacts resulting from combined sewer overflow.

Grants for combined sewer overflow control have been awarded for 6.4 percent and requested for 16.8 percent of the total combined sewer overflow control needs of an estimated $21.16 billion. Thus, grants have been made or requested for a total of 24.2 percent of the estimated needs.

The time required to provide needed funds to correct combined sewer overflow problems varies widely among the States. The most sensitive variables affecting this time are Federal allocation of construction grant funds to the States, State allocation of funds to combined sewer overflow control, and annual rate of construction cost increase.

If the annual construction cost increase is matched by an increase in Federal and State funding for combined sewers, average time to fund correction for all States ranges between 8 and 14 years for the alternative allocation funding formulae assumed in the report. The maximum time for any State ranges from 14 to 40 years depending on the assumptions.

A comparison of the pollutant loads from only the national combined sewer area shows that more than 80 percent of the total annual lead and suspended solids loads are delivered to the receiving waters from combined sewer overflows. More than 80 percent of the annual nutrient (phosphorus and nitrogen) loads are delivered to the receiving waters from secondary wastewater treatment plant effluent. Annual BOD_5, (biochemical oxygen demand) loads are split evenly between secondary wastewater treatment plants' effluent and combined sewer overflow.

Five legislative alternatives are analyzed in the report. EPA recommends the first alternative, to continue with the present law. The success of this alternative in providing timely funding for control of combined sewer overflow will depend principally on the amount of money available to States with serious combined sewer problems, the proportion of these funds assigned by the States to combined sewer projects, and the annual rate of increase in construction costs.

We have based this report on the best available information, including unpublished data we are gathering in the current "needs" survey for the next report to Congress on the cost of needed publicly-owned treatment works. The "needs" survey results, due February 10, 1979, will permit us to refine the conclusions and recommendation in this report. The "needs" survey results will, for example, provide a revised estimate by State of the cost of controlling combined sewer overflow, and an analysis of the impact of pollutant loads for combined sewers on receiving waters.

I would be pleased to discuss further the recommendations made in this report at your convenience.

Sincerely yours,

Douglas M. Costle

CONTENTS

Page

TABLES vi

FIGURES vii

ACKNOWLEDGMENTS viii

Executive Summary ES - 1

Chapter

1 INTRODUCTION 1 - 1
  MANDATE 1 - 3
  SCOPE 1 - 3
  OVERVIEW OF OTHER URBAN WATER RESOURCES NEEDS 1 - 5
  THE 1978 NEEDS SURVEY 1 - 5

2 OUTLINE OF LEGISLATIVE ALTERNATIVES 2 - 1
  ALTERNATIVE 1--CONTINUE WITH PRESENT LAW 2 - 1
  ALTERNATIVE 2--MODIFICATION OF CURRENT LAW TO PROVIDE CONGRESSIONAL FUNDING OF LARGER PROJECTS 2 - 1
  ALTERNATIVE 3--MODIFICATION OF CURRENT LAW TO PROVIDE FUNDING FOR NONSTRUCTURAL CONTROL TECHNIQUES 2 - 1
  ALTERNATIVE 4--MODIFICATION OF CURRENT LAW TO PROVIDE A SEPARATE FUNDING FOR COMBINED SEWER OVERFLOW PROJECTS 2 - 2
  ALTERNATIVE 5--DEVELOPMENT OF A NEW LAW TO PROVIDE FUNDING FOR MULTIPURPOSE URBAN WATER RESOURCES PROJECTS 2 - 2
  REVIEW 2 - 2

3 CURRENT STATUS OF CSO PROJECTS 3 - 1
  SOURCES OF DATA 3 - 1
  DEVELOPMENT OF GRANT NUMBER FILE 3 - 2
  PROCEDURE TO WRITE REPORT 3 - 2
  QUALITY OF DATA 3 - 2
  RESULTS 3 - 2

4 CSO NEEDS 4 - 1
  PROCEDURE TO WRITE REPORT 4 - 1
  QUALITY OF DATA 4 - 1
  RESULTS 4 - 1

CONTENTS--Continued

Chapter Page

5 CSO CORRECTION TIME 5 - 1
OVERALL ESTIMATE OF TIME REQUIRED TO FUND CSO POLLUTION CONTROL PROJECTS 5 - 1
URBAN AREAS WITH MAJOR NEEDS 5 - 3
STATE-BY-STATE ESTIMATES OF TIME REQUIRED TO FUND CSO POLLUTION CONTROL PROJECTS 5 - 3
Allocation Formulas 5 - 7
Rate of Spending 5 - 7

6 COMPARISON OF ANNUAL POLLUTANT DISCHARGES 6 - 1
SUMMARY OF POLLUTANT DISCHARGE ANALYSIS 6 - 1
Drainage Areas and Populations of the Study Sites 6 - 4
Procedure for Estimating Pollutant Loads 6 - 4
RESULTS 6 - 9
Nationwide 6 - 9
15 Study Sites 6 - 12

7 TECHNOLOGICAL ALTERNATIVES FOR COMBINED SEWER OVERFLOW CONTROL 7 - 1
INTRODUCTION 7 - 1
PROCESS DEFINITIONS 7 - 2
Source Controls 7 - 2
Collection System Controls 7 - 3
Treatment Facilities 7 - 5
COST EFFECTIVENESS 7 - 8
ENERGY USE 7 - 13
COMPARISON OF 25-MGD CSO TREATMENT FACILITIES 7 - 16

8 DISCUSSION OF LEGISLATIVE ALTERNATIVES 8 - 1
ALTERNATIVE 1--CONTINUE WITH PRESENT LAW 8 - 1
Advantages of Alternative 1 8 - 2
Disadvantages of Alternative 1 8 - 2
ALTERNATIVE 2--MODIFICATION OF CURRENT LAW TO PROVIDE CONGRESSIONAL FUNDING OF LARGER PROJECTS 8 - 4
Advantages of Alternative 2 8 - 5
Disadvantages of Alternative 2 8 - 5
ALTERNATIVE 3--MODIFICATION OF CURRENT LAW TO PROVIDE FUNDING FOR NONSTRUCTURAL CONTROL TECHNIQUES 8 - 5
Disadvantages of Alternative 3 8 - 6
Disadvantages of Alternative 3 8 - 6

CONTENTS--Continued

Chapter		Page
8	ALTERNATIVE 4--MODIFICATION OF CURRENT LAW TO PROVIDE A SEPARATE FUNDING FOR COMBINED SEWER OVERFLOW PROJECTS	8 - 7
	Advantages of Alternative 4	8 - 8
	Disadvantages of Alternative 4	8 - 8
	ALTERNATIVE 5--DEVELOPMENT OF A NEW LAW TO PROVIDE FUNDING FOR MULTIPURPOSE URBAN WATER RESOURCES PROJECTS	8 - 8
	Advantages of Alternative 5	8 - 9
	Disadvantages of Alternative 5	8 - 10
	SUMMARY OF ALTERNATIVES	8 - 10
	RECOMMENDATIONS	8 - 11

Appendix		Page
A	CORRESPONDENCE	A - 1
B	COMPARISON OF POLLUTANT DISCHARGES FOR 15 CITIES	B - 1
C	DESCRIPTION OF TECHNOLOGICAL ALTERNATIVES	C - 1

TABLES

Table		Page
1-1	Annual Cost of Construction and Operation and Maintenance for Selected Urban Water Facilities	1 - 6
3-1	Summary of Funded Grant Amounts for CSO Pollution Control	3 - 4
4-1	Summary of Requested Grant Amounts for CSO Pollution Control	4 - 2
5-1	SMSA's with Combined Sewer Service Area Greater Than 10,000 Acres	5 - 4
5-2	State-by-State Estimates of Time Required to Fund CSO Pollution Control Projects for Six Funding Alternatives	5 - 9
6-1	Drainage Areas and Populations for 15 Study Site Pollutant Loading Comparisons	6 - 3
6-2	Drainage Areas and Populations for 18 Urbanized Areas Pollutant Loading Comparisons	6 - 5
6-3	Summary of Combined Sewer Drainage Areas and Populations	6 - 6
6-4	Stormwater Average Areal Load Equations	6 - 8
6-5	Secondary Wastewater Treatment Plant Effluent Concentrations for the 1978 Needs Survey	6 - 10
6-6	BOD_5 Ratios for Stormwater Loads	6 - 10
6-7	Nationwide Comparison of Annual Discharges From Combined Sewer Overflow and Secondary Wastewater Treatment Plant Effluent	6 - 11
6-8	Percentage of Sites Where Indicated Source Contributes More Than 33% of the Total Pollutant Discharge	6 - 13
7-1	Range of Feasibility and Unit Costs for CSO Technological Alternatives	7 - 11

TABLES--Continued

Table		Page
7-2	Energy Use for Several CSO Control Alternatives	7 - 14
7-3	Comparison of Seven 25-mgd CSO Treatment Systems	7 - 17

FIGURES

Figure

1-1 Geographic Distribution of Population Served by Combined Sewer Systems

5-1 Estimates of CSO Pollution Correction Times

6-1 Location of 15 Pollutant Loading Comparisons

6-2 BOD_5 Discharge from Combined Sewer Overflow versus Combined Sewer Area

6-3 Suspended Solids Discharge from Combined Sewer Overflow versus Combined Sewer Area

6-4 Total Nitrogen Discharge from Combined Sewer Overflow versus Combined Sewer Area

6-5 Phosphate Phosphorus Discharge from Combined Sewer Overflow versus Combined Sewer Area

6-6 Lead Discharge from Combined Sewer Overflow versus Combined Sewer Area

7-1 Unit Removal Cost for a Typical Combined Sewer Service Area

ACKNOWLEDGMENTS

This report was prepared by CH2M HILL, Inc. James E. Scholl developed the pollutant loading comparisons and the evaluation of technological alternatives. Michael J. Mara served as project systems analyst and developed the CSO Funding Status reports. Typing and editorial services were provided by the Gainesville Office Word Processing Center. Ronald L. Wycoff served as project manager.

Especially acknowledged is the leadership and review of Philip H. Graham, Facilities Requirements Branch, Municipal Construction Division, EPA, who was the Project Officer; and Michael Cook, Chief, Facilities Requirements Branch, EPA. Both of these individuals provided valuable guidance and review throughout the project. Numerous other individuals both within and outside of EPA provided significant cooperation and direct participation in the preparation of this report.

SUMMARY INFORMATION ON COMBINED SEWER AREAS

There are approximately 1,300 communities in the United States which have a total combined sewer area of 2-1/4 million acres, serving a total of 38 million persons. Eighty three percent of the combined sewer area and 81% of the resident population served are concentrated in 58 cities located in 24 states.

STATUS OF CONSTRUCTION GRANTS FOR CONTROL OF POLLUTION FROM COMBINED SEWER OVERFLOW

Total national needs for control of pollution from combined sewer overflow (CSO) were estimated by the 1976 Needs Survey to be $18.26 billion in January 1976 dollars. Updating this estimate to January 1978 dollars yields a total national need of approximately $21.16 billion. Previously met needs estimated and reported in Table 3-1 are approximately $1.36 billion based on 75% grant eligibility. Remaining unmet needs are, therefore, approximately $19.81 billion.

Based on information provided by the FY 1978 project priority list, as of 23 June 1978, construction grants have been requested but are not yet funded for an additional $2.67 billion, as reported in Table 4-1. Based on 75% grant eligibility, these construction grants would generate an additional $3.56 billion in construction funds. From these estimates, it may be concluded that approximately 6.4% of national CSO pollution control needs have been met and that an additional 16.8% of the national needs have been specifically identified.

ESTIMATED TIME REQUIRED TO FUND COMBINED SEWER OVERFLOW POLLUTION CONTROL PROJECTS

The overall time required to control pollution from combined sewer systems is summarized in Figure 5-1.

This figure illustrates the importance of maintaining constant buying power in the construction grants program if CSO correction is to be achieved in a reasonable period of time. Constant buying power is assured if the annual total construction grants allocation is increased each year by a percentage equal to the percentage increase in construction costs during the preceding year.

Six estimates of the time required to fund CSO correction projects by state are developed and are based on the assumption that future buying power will remain constant (i.e., total funding equals 5.0 billion January 1978 dollars annually). The assumptions associated with each estimate are related to the grant allocation formula and to the rate of state funding for CSO control. The following grant allocation formulas are considered.

1. Construction grant funds will be allocated to each state under the present allocation formula.

2. Construction grant funds will be allocated to each state under a new formula. This formula proportions state allocations based on the ratio of state needs to total national needs for combined sewer overflow control (Category V) and on the ratio of state needs to total national needs for all other municipal wastewater control facilities (Categories I through IVB). The weighting factors are 20% for Category V and 80% for Categories I through IVB.

3. Construction grant funds will be allocated to each state under a new formula. This formula is identical to 2 above except that the weighting factors are changed to 50% for Category V and 50% for Categories I through IVB.

Once grant funds are allocated to each state, it is the state's decision as to which projects are funded. This decision is made based on a project's standing on the state's project priority list. It is probable that, as secondary wastewater treatment plant needs are met, combined sewer overflow pollution abatement needs will receive higher priority. The following two alternative assumptions were made concerning the rate of spending by states with CSO needs.

a. States with combined sewer systems will invest in CSO control facilities at a uniformly changing rate until a maximum of 50% of the annual allocation is invested in CSO control. The transition from the present rate of investment in CSO control facilities to the maximum rate of 50% will require 5 years.

b. The second spending assumption is identical to No. 1 above except that the maximum spending rate is reduced from 50% to 30%.

Assumptions which are common to each of the above funding formula and spending alternatives are as follows.

1. Funding level for construction grants is $4.25 billion per year for current year and $5.0 billion per year thereafter. Funds are expressed in January 1978 dollars (i.e., constant buying power).
2. The current funding formula will be in effect from 1 October 1978 through 30 September 1981.

The allocation and spending alternatives are referenced to an alphanumeric identifier, 1a, 2a, 3a, 1b, 2b, and 3b, which represents all possible combinations of the three allocation formulas and two spending rates. The average and maximum times to fund CSO correction projects for each allocation and spending alternative are summarized in the following table. Individual estimates for each state are reported in Table 5-2.

Summary of Time Required
To Fund CSO Correction Projects

	Time in Years by Alternative					
	1a	2a	3a	1b	2b	3b
Maximum	25	24	14	40	38	21
Average	9.78	9.36	8.26	14.20	13.64	11.84

The results of the analysis summarized above indicate that the time to fund CSO correction projects will be highly variable from state to state. Average times may vary from approximately 8.3 years to 14.3 years and maximum times may vary from approximately 14 years to 40 years for the six alternatives analyzed. It also appears that the rate at which states fund CSO projects will have a greater influence on correction time than would modification of the grants allocation formula.

It should be emphasized that these values represent time required to fund CSO projects. The actual construction of the projects will require an additional 2 to 5 years in each case.

Also, water pollution control facilities have an economic life ranging from 10 to 15 years for mechanical equipment and from 20 to 50 years for plants and collection systems. Therefore, the process of facilities construction should be realistically viewed as continuous.

POLLUTANT DISCHARGE FROM COMBINED SEWER OVERFLOW

An important characteristic of CSO is its concentrated location. Combined sewer systems are located in some of the most heavily populated urban centers of our nation. Thus, the pollutant discharge is limited to the generally short reaches of the receiving water located near the highest concentrations of population. Thus, many millions of people observe and are exposed to the receiving water impacts resulting from combined sewer overflow.

Combined sewer overflow can be a significant source of pollution in certain cases. The relative importance of CSO depends upon the ratio of combined sewer service area to separate sewer service area. In general, combined sewers are a major source of oxygen-demanding materials (BOD_5) and suspended solids (SS). Wastewater treatment plant effluent is generally the major source of nutrients and urban stormwater runoff is the major source of lead. Other constituents, such as benzene and cadmium, were not considered in this investigation because of a lack of generalized loading data for combined sewer service areas.

Another important characteristic of CSO as demonstrated in the site studies, is the intermittent nature of the discharge. Combined sewer overflow occurs only during runoff-producing rainfall events which, in general, range from 200 to 1,300 hours per year or from 2% to 15% of the time. Thus, pollutant loading rates during runoff events may be extremely large. Combined sewer overflow contains raw wastewater which may contain disease organisms, is usually repugnant, and results in unpleasant odors. During combined sewer overflow events, heavier particulate organic material settles to the bottom of the waterway and contributes to a benthic load which detrimentally impacts the receiving water, even during dry weather periods. Floatable and soluble organic material can impact the waterway with a shock pollution loading which can negate any fishable or swimmable goals. The impact of a large combined sewer overflow event on any viable aquatic biota element in the receiving water can be extremely determinatal.

There are at least 2-1/4 million acres of combined sewer service area in the United States today with an average population density of 16.7 persons per acre. A comparison of annual pollutant loads from the total national combined sewer service area resulting from overflow and from secondary WWTP effluent reveals:

1. Five-day biological oxygen demand (BOD_5) discharge is approximately the same for CSO and for secondary WWTP effluent.

2. Suspended solids (SS) discharge is approximately 15 times greater from CSO than from secondary WWTP effluent.

3. Total nitrogen (TN) discharge from CSO is only about 14% of the discharge from secondary WWTP effluent.

4. Orthophosphate (PO_4) discharge from CSO is only about 27% of the discharge from secondary WWTP effluent.

5. Lead (Pb) discharge is approximately 4 times greater from CSO than from secondary WWTP effluent.

In this report, pollutant loading comparisons are developed for 18 urbanized areas served by a total of 727,000 acres of combined sewer service area. These comparisons are developed for combined sewer overflow, urban stormwater runoff, and secondary WWTP effluent on an annual basis and on an average runoff event basis. That is, pollutant discharges are compared during the time span of 1 year and during the time span of an average runoff event.

Since three pollutant sources are compared, a source is termed major if it accounts for more than 1/3 of the pollutants discharged during the time period of comparison. Results of the 18 urbanized areas comparison on an annual loading basis are:

1. Secondary WWTP effluent is the major source of BOD_5.

2. CSO and urban stormwater runoff are the major sources of SS.

3. Secondary WWTP effluent is the major source of the nutrients TN and PO_4.

4. Urban stormwater runoff is the major source of Pb.

Results of the 18 urbanized areas comparison on a average runoff event basis are:

1. CSO and urban stormwater runoff are the major sources of BOD_5.

2. CSO and urban stormwater runoff are the major sources of SS.

3. CSO and secondary WWTP effluent are the major sources of the nutrients TN and PO_4.

4. Urban stormwater runoff is the major source of Pb.

The reader should keep in mind that the above summary of pollutant loading results is a composite summary and that every combined sewer system, the urban area in which it is located, and the receiving water into which it discharges constitutes a unique system which requires individual analysis.

TECHNOLOGICAL ALTERNATIVES AVAILABLE FOR CONTROL OF POLLUTION FROM COMBINED SEWER OVERFLOW

There are many viable technological alternatives available for control of pollution from combined sewer overflow. There is, however, no single "best alternative" which can be applied to all cases. The least cost solution in a given case is a function of the degree of pollution removal required and the physical and hydrologic characteristics of the combined sewer service area. Each situation requires individual planning and analysis.

CSO problems are unique to the given collection system. The first objective of any combined sewer overflow pollution control project should be to obtain an understanding of how the existing collection system operates, including an investigation of the existing regulator system. Collection systems will not perform as designed unless they are operated and maintained properly. If not maintained properly, overflow of raw wastewater can occur during dry weather on a nearly continuous basis.

The Office of Research and Development of the Environmental Protection Agency has invested about $45 million in research and demonstration projects for combined sewer overflow control. The results of this research are published in the Environmental Protection Technology Series and may be applied to the planning and design of combined sewer overflow pollution abatement facilities. Given the magnitude of the needs which are on the order of $20 billion, it is clear that investment in additional research would likely yield substantial net savings to the public. For example, if additional research resulted in development and demonstration of technologies which are 5% more efficient than technologies available today, $1 billion could be saved.

This report presents an analysis of the unit removal costs expressed in dollars per pound of BOD_5 removed from the receiving water for a typical combined sewer watershed. Unit removal costs are developed for nonstructural or low-structural control alternatives such as street sweeping, catch basin cleaning, and sewer flusing as well as for structural or capital intensive controls which involve storage and/or treatment. The results of this analysis for nonstructural or low-structural controls are:

1. Streetsweeping can be used to remove from 2% to 11% of the watershed BOD_5 load at a cost of from approximately \$3.00 to \$7.50 pound of BOD_5 removed.

2. Catch basin cleaning is not a viable alternative because of low removal and high cost.

3. Sewer flushing can be used to remove from 20% to 50% of the watershed BOD_5 load at a cost of from less than \$2 to approximately \$14 per pound of BOD_5 removed.

4. Swirl concentrators/regulators can be used to remove from 30% to 55% of the watershed BOD_5 load at a cost of from \$2 to \$4 per pound of BOD_5 removed.

The costs and effectiveness of storage/treatment systems depend to a large extent upon the size of the area served. Storage/treatment systems become more cost effective as the area served by a given facility increases. For a small watershed of 100 acres or less, sewer separations may be a cost-effective control alternative. Sewer separation with subsequent treatment at a secondary WWTP will remove approximately 65% of the total watershed BOD_5 load at a unit cost of approximately \$24 per pound removed. For watersheds greater than about 200 acres, storage/treatment systems will become more cost effective than sewer separation. A typical relationship between facility size percentage of BOD removal and unit cost is illustrated on Figure 7-1 of this report.

The following comments pertain to storage/treatment systems.

1. In-line storage including real time control (RTC) of the collection system is a viable alternative if the existing collection system has a large interceptor storage capacity. In-line storage with subsequent treatment at a secondary WWTP will remove up to 45% (possibly more in collection systems not yet investigated) of the watershed BOD_5 load at a cost of from \$1.25 to \$4 per pound of BOD_5 removed.

2. Off-line storage in a highly developed urban area is expensive. In many cases, covered concrete storage basins will be required to permit dual land use. Therefore, economic optimization of all proposed storage/treatment systems should be required before construction funds are granted.

3. Storage/treatment systems are the only technologically viable alternative for removal of more than about 65% of the total annual watershed BOD_5 load.

4. For large watersheds greater than 2,000 acres in size, the optimum storage/treatment system can be used to remove from 30% to 80% of the watershed BOD_5 load at a cost of from $3 to $4 per pound of BOD_5 removed.

The incremental cost of Advanced Wastewater Treatment (AWT) is in the range of $1.90 to $7.00 per pound of BOD removed depending upon the size of the plant and the final effluent quality. These unit removal costs are comparable to available CSO control unit removal costs. Therefore, there is no clear economic advantage for CSO control over AWT. The decision to construct AWT and/or CSO control facilities at a given site must be based on individual economic and water quality impact analysis.

The reader should remember that the discussions of pollutant loadings and technological alternatives presented in this Executive Summary and in the main body of the report represents a summary of our understanding of the CSO pollution problem as it exists today and that this understanding is ever-changing. Much information has been developed in the last few years, and it is probable that much more will be developed in the future.

LEGISLATIVE ALTERNATIVES FOR FUNDING COMBINED SEWER OVERFLOW POLLUTION ABATEMENT PROJECTS

Five basic legislative alternatives for funding CSO pollution abatement projects are defined in Chapter 2 and discussed in Chapter 8 of this report. They are:

1. Continue with present law.

2. Modification of present law to provide congressional funding of larger projects.

3. Modification of present law to provide funding for nonstructural control techniques.

4. Modification of present law to provide a separate funding for combined sewer overflow projects.

5. Development of a new law to provide funding for multi-purpose urban water resources projects.

The five legislative alternatives, including a brief discussion of each, were submitted to various state agencies and municipalities as well as to EPA staff for comment and review. Comments received by state and municipal officials are presented in Appendix A.

Alternative 1 "Continue with Present Law" appears to be one of the most viable alternatives and would probably result in minimum construction delays. Total time to correction would remain an unknown since all projects would be subject to the states' project priority system.

Alternative 2 "Modification of Current Law to Provide Congressional Funding of Larger Projects" received little support from local and state officials submitting comments. This alternative is perceived as adding substantial delays and uncertainty to the CSO pollution abatement process without adding any quality to the end product.

Alternative 3 "Modification of Current Law to Provide Funding for Nonstructural Control Techniques" does not at this time appear viable because of its limited probable benefits and the high risk of expanding the federal role in water quality control far beyond current limits.

Alternative 4 "Modification of Current Law to Provide a Separate Funding for Combined Sewer Overflow Projects" also appears to be one of the most viable and workable solutions to the problem of funding CSO pollution abatement projects. In general, individuals located in areas of the country with major combined sewer service areas who submitted comments on the alternatives favored Alternative 4 with a national fund (separate grants program) while individuals located in areas of the country with few combined sewer systems who submitted comments favored Alternative 1.

Alternative 5 "Development of a New Law to Provide Funding for Multipurpose Urban Water Resources Projects" raises questions of national urban water resources policy far beyond the question of CSO pollution control. Most individuals who submitted comments questioned the workability of such an approach, based in part upon anticipated substantial construction delays.

It is recommended that Alternative 1 "Continue with Present Law" be adopted as the funding method for future combined sewer overflow pollution abatement projects. However, if CSO pollution is to be corrected in a reasonable period of time, states with substantial CSO needs must be willing to spend a large share of their annual allocation on CSO projects. Moreover, the relative size of the allocation to these states would be increased if national appropriations were allocated among the states based to a greater degree on CSO needs.

It must be remembered that any increase in spending for combined sewer overflow control needs (Category V) will result in a decrease in spending for all other pollution control needs (Categories I-IV B). These tradeoffs must be weighed carefully for any given municipality. It is believed that this site-specific examination of pollution control tradeoffs can best be accomplished in a timely fashion under the present law.

This report is based on the best information available, including unpublished data currently being gathered as part of the 1978 Needs Survey for the report to Congress on cost of needed publicly-owned treatment works. The Needs Survey results, due 10 February 1979, will permit refinement of the conclusions and recommendation in this report. The Needs Survey results will, for example, provide a revised estimate, by state, of the cost of controlling combined sewer overflow, and an analysis of the impact of pollutant loads from combined sewers on receiving waters.

Chapter 1
INTRODUCTION

Combined sewers are defined as wastewater collection systems designed to transport both sanitary wastes and stormwater runoff in the same conduits. A separate sanitary sewer system, on the other hand, is designed to transport only sanitary wastewater while storm water is conveyed by separate storm sewers.

During wet weather, combined sewer systems may overflow directly to the receiving water and the combined sanitary wastes and stormwater runoff are discharged without treatment. Overflow points and treatment plant bypasses are provided, by design, to prevent damage to the wastewater treatment plant (WWTP) and to reduce local flooding during periods of high flow. Combined sewer discharge can be a major source of pollution during the period of overflow. Combined sewer overflow can also be a source of long-term pollution in the receiving water since solids are discharged which settle to the bottom and form sludge deposits. These deposits exert long-term oxygen demand which persist during periods of dry weather.

Until the turn of the 20th century, constructing combined sewer systems was accepted practice where population densities were great enough to require both urban drainage and sanitary wastewater transport. Small towns with less densely populated areas were frequently drained by natural watercourses, and thus only wastewater collection was required. In these cases, separate sanitary sewers were constructed.

By the end of the 19th century, the need for wastewater treatment became increasingly apparent. Therefore the advantage of a separate collection system designed to transport wastewater only also became apparent. For this reason, nearly all wastewater collection systems constructed after the turn of the century were separate systems.

Because of the period in which they were built, combined sewer systems tend to be located in areas of the country which experienced growth during the period from approximately 1850 through 1900. Major combined sewer service areas are located along the upper east coast, in the upper midwest, and in the far west. The geographic distribution of population served by combined sewer systems is illustrated on Figure 1-1.

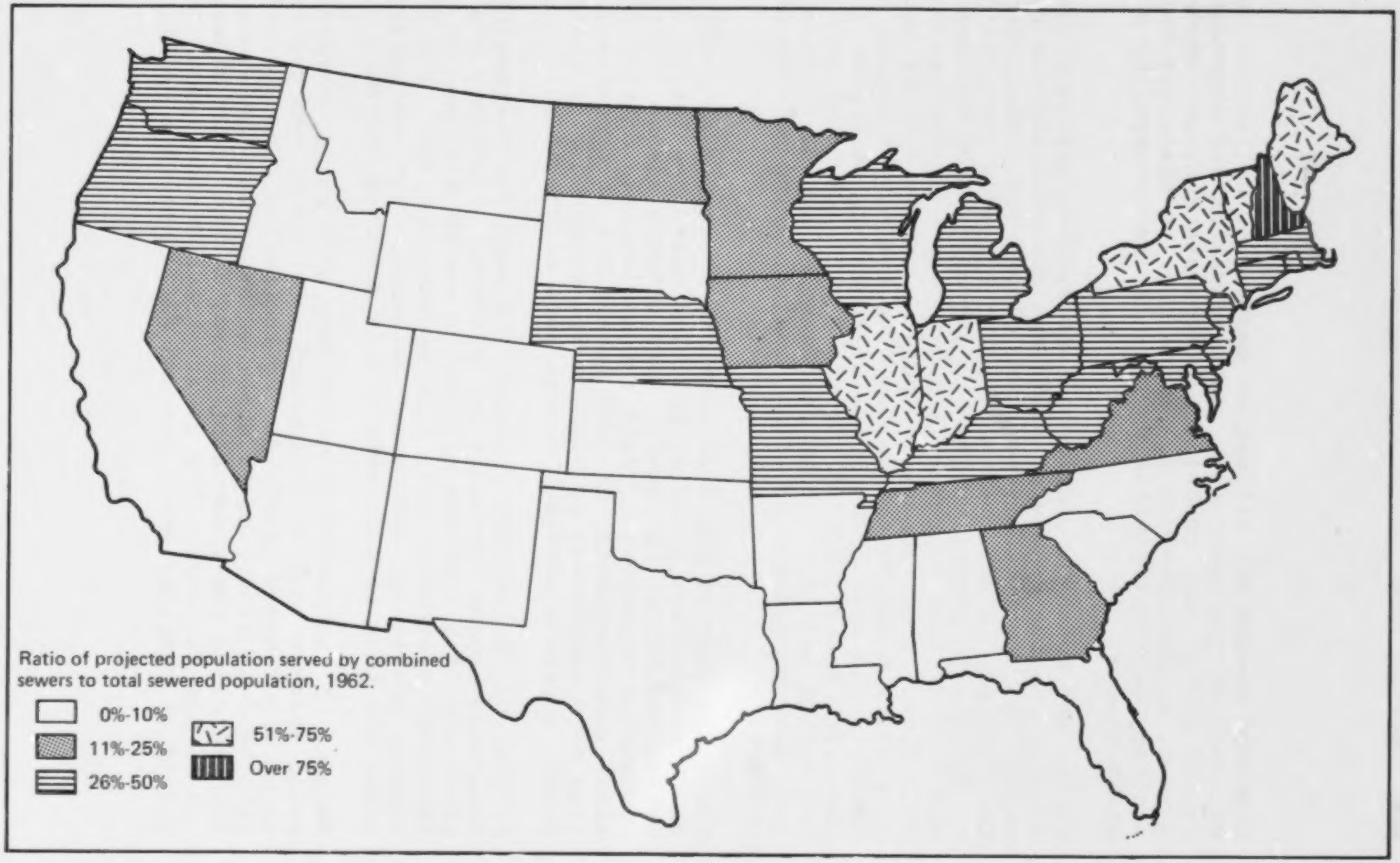

Ratio of projected population served by combined sewers to total sewered population, 1962.
☐ 0%-10%
▨ 11%-25%
▤ 26%-50%
▨ 51%-75%
▥ Over 75%

FIGURE 1-1. Geographic Distribution of Population Served by Combined Sewer Systems.

There are at least 2-1/4 million acres of combined sewer service area in the United States today located in 1,100 to 1,300 distinct collection systems. These systems serve approximately 38 million people. However, about 83% of the national total area is located in 58 major cities. Thus these cities comprise most of the national needs for CSO control.

MANDATE

Section 516(c) of the 1977 Clean Water Act provides that:

> "(c) The Administrator shall submit to the Congress by October 1, 1978, a report on the status of combined sewer overflows in municipal treatment works operations. The report shall include (1) the status of any projects funded under the Act to address combined sewer overflows, (2) a listing by State of combined sewer overflow needs identified in the 1977 State priority listings, (3) an estimate for each applicable municipality of the number of years necessary, assuming an annual authorization and appropriation for the construction grants program of $5,000,000,000 to correct combined sewer overflow problems, (4) an analysis using representative municipalities faced with major combined sewer overflow needs, of the annual discharges of pollutants from overflows in comparison to treated effluent discharges, (5) an analysis of technological alternatives available to municipalities to correct major combined sewer overflow problems, and (6) any recommendations of the Administrator for legislation to address the problem of combined sewer overflows, including whether a separate authorization and grant program should be established by the Congress to address combined sewer overflows."

This report, "Control of Combined Sewer Overflow in the United States," responds to the above mandate.

SCOPE

The report addresses each of the six items outlined in Section 516 (c) of the 1977 Clean Water Act. Chapter 2 presents a brief outline of the five basic legislative alternatives for funding combined sewer overflow pollution abatement projects considered in this study.

Chapter 3 discusses the current status of funded combined sewer overflow pollution abatement projects by state. The amount currently funded by state is compared to estimated national needs as reported in the 1976 Needs Survey.

Chapter 4 discusses the status of currently unfunded but indentified projects. This total is also compared on a state-by-state basis to estimated national needs as reported in the 1976 Needs Survey.

Combined sewer overflow pollution abatement correction time is discussed in Chapter 5. It is assumed that $5 billion per year will be available for all municipal construction grants. A relationship between overall correction time and level of funding for combined sewer overflow pollution abatement is presented. In addition, state-by-state estimates of correction time are developed based on three alternative grant allocation formulas, including the present formula.

Estimated annual pollutant discharge from combined sewer overflow, wastewater treatment plant effluent, and urban stormwater runoff generated by 15 different urban areas are compared in Chapter 6. The pollutants considered are:

1. 5-day biochemical oxygen demand (BOD_5).

2. Suspended solids (SS).

3. Orthophosphate (PO_4 as PO_4).

4. Total nitrogen (TN).

5. Total lead (Pb).

In addition to the annual loadings, relative loading rates during runoff events are also estimated and compared.

There is a general lack of data regarding toxics in combined sewer overflow and their receiving waters. A limited amount of lead loading data are available and, therefore, estimates of lead loadings are presented. However, background receiving water lead data are rare and sampling intervals are long (i.e., 4 samples per year). Therefore, receiving water impact analysis is difficult. Other constituents, such as benzene and cadimum, were not used in this analysis because of a lack of generalized loading data.

A brief discussion of selected technological alternatives for control of pollution from combined sewer overflow is presented in Chapter 7. Advantages and disadvantages of these techniques including unit cost treatment effectiveness and energy use are presented in Chapter 7 and in Appendix C.

The final chapter is a discussion of the advantages and disadvantages of the five legislative alternatives presented in Chapter 2.

OVERVIEW OF OTHER URBAN WATER RESOURCES NEEDS

The subject of this report is limited to the status of and alternatives for the abatement of pollution resulting from combined sewer overflow, which is a major urban water resources need. However, it is only one part of a total urban pollution control program and urban pollution control is only one part of total urban water resources needs.

In 1971 the Office of Water Resources Research, U.S. Department of the Interior published a report entitled "A National Urban Water Resources Research Program." This report summarized expected annual costs for construction and operation and maintenance of selected urban water facilities including facilities unrelated to pollution control. These estimates for water supply and urban drainage are presented in Table 1-1 in order to provide a perspective or overview of nonpollution control aspects of the urban water problem.

Inspection of Table 1-1 indicates that outlays for nonpollution aspects of urban water resources management, particularly urban drainage, are significant. The cost base for these estimates was not given; however, if it is assumed that the cost base is mid-1967 (approximate date of publication of the original data) dollars, then the total annual outlay of $7.66 billion becomes approximately $19 billion per year in January 1978 dollars. Obviously urban water resources is a subject which deserves the attention of federal as well as state and local decision makers.

THE 1978 NEEDS SURVEY

At the time of this writing (August 1978), the 1978 Needs Survey for Control of Pollution from Combined Sewer Overflow and Urban Stormwater Runoff is under way. The results of this survey will be available in February 1979.

There are two major elements of the ongoing Needs Survey work which are related to this report. First, 10 of the 15 cities for which loading comparisons are developed in Chapter 6 are included as detailed site studies in the Needs Survey. In addition to the estimated pollutant loadings presented here, the Needs Survey will present a receiving water impact analysis and an estimate of the improvement in receiving water quality obtained by removing a portion of the total load. Analysis of receiving water impacts of CSO, preferably on a continuous basis, is necessary in order to plan effective CSO control strategies.

Preliminary results of the Needs Survey site impact analysis available to date indicate that CSO may have adverse impacts

Table 1-1
Annual Cost of Construction and Operation and Maintenance
for Selected Urban Water Facilities

Service	Period for Average	Annual Construction Cost (million dollars)		Annual O&M Cost[a] (million dollars)
		Replacement	Growth	
Water distribution	1967-1980	758	788	2,319
Water treatment plants	1967-1980	253	264	776
Urban drainage (storm sewers)	1966-1975	1,300	1,200	NA
Totals		2,311	2,252	3,095

Grant total $7.66 billion per year

Note: Data from "A National Urban Water Resources Research Program"--cost base not cited.

[a] Includes nonconstruction capital outlays and debt service.

on the dissolved oxygen budget of the receiving water and may be a major source of suspended solids. CSO is generally not the major source of nutrients or lead except in cases where the CSO service area is extensive compared to the separate sewered service area. CSO is also a major source of fecal coliform bacteria. Fecal coliform concentrations are generally an order magnitude higher for CSO than for separate urban stormwater runoff.

The second major element of the ongoing Needs Survey work involves the establishment of a National Combined Sewer System Data File. The objective of this portion of the project is to assemble certain basic data on each combined sewer system in the nation. These data include location, sewer system characteristics, receiving water characteristics, and the status of CSO correction planning. Preliminary results of this data-gathering effort are used in part in Chapter 5 to establish the location and size of the major combined sewer systems in the United States.

Chapter 2
OUTLINE OF LEGISLATIVE ALTERNATIVES

Five basic legislative alternatives for funding combined sewer overflow pollution abatement projects have been identified and are discussed in this report. The final chapter of the report presents a summary discussion of each alternative including advantages and disadvantages. The five alternatives are defined here so that they may be discussed in the subsequent chapters of the report.

ALTERNATIVE 1--CONTINUE WITH PRESENT LAW

Combined sewer overflow pollution abatement projects would be funded under the existing provision of PL 92-500 as amended in December 1977 by the Clean Water Act of 1977. Combined sewer overflow control projects would be funded under section 201 of the law.

ALTERNATIVE 2--MODIFICATION OF CURRENT LAW TO PROVIDE CONGRESSIONAL FUNDING OF LARGER PROJECTS

Major combined sewer overflow pollution abatement projects would be subject to funding on a case-by-case basis. Once the planning process is complete, each project would be presented to Congress. Congress would have a clear picture of the costs likely to be incurred and the benefits likely to accrue from the plan. The decision whether to fund all of the project, a portion of the project, or none of the project would rest with Congress.

ALTERNATIVE 3--MODIFICATION OF CURRENT LAW TO PROVIDE FUNDING FOR NONSTRUCTURAL CONTROL TECHNIQUES

Combined sewer overflow pollution abatement projects may include a mixture of both structural controls and management practices. Management practices consist of those techniques which require very few, if any, capital expenditures. Such operation and maintenance costs are not grant eligible under the current law.

ALTERNATIVE 4--MODIFICATION OF CURRENT LAW TO PROVIDE A SEPARATE FUNDING FOR COMBINED SEWER OVERFLOW PROJECTS

Combined sewer overflow pollution abatement projects would be funded from amounts specifically earmarked by Congress for this purpose. The funds could be made available either from a national fund or as a set-aside within each State's allotment of grant funds.

ALTERNATIVE 5--DEVELOPMENT OF A NEW LAW TO PROVIDE FUNDING FOR MULTIPURPOSE URBAN WATER RESOURCES PROJECTS

The new legislation would provide for multipurpose urban water resources projects planning and construction funding. The objectives may include: (1) recreation, (2) urban drainage, (3) point source pollution control, (4) control of pollution from combined sewer overflows, (5) control of pollution from urban storm-water runoff, (6) urban water supply including water reuse, and (7) major flood control projects. Funds for those portions of each project which provide substantial benefits relative to costs could be authorized by Congress on a case-by-case basis, or drawn from existing programs such as those administered by EPA, HUD, and EDA.

REVIEW

The five legislative alternatives as outlined above were submitted to various state agencies and municipalities as well as EPA staff for comment and review. Comments received before 1 September 1978 from state and municipal officials are presented in Appendix A. These comments are presented in alphabetical order by (1) state agencies, (2) interstate commissions, (3) councils of governments, and (4) cities and wastewater authorities.

Chapter 3
CURRENT STATUS OF CSO PROJECTS

The objective of this phase of the investigation was to develop a status report for projects funded under PL 92-500, which addresses combined sewer overflow pollution abatement.

SOURCES OF DATA

Two data files were used in developing the required information: the EPA Combined Sewer System Data File which is currently being developed and the EPA Grants Information and Control System Data File. The data obtained from these files were supplemented with information obtained from EPA regional offices.

The Grants Information and Control System Data File (GICS) is an agencywide, computer-oriented management information system that contains general purpose information on all EPA grant programs, whether the program is administered through headquarters or through a regional office. The GICS file contains information on federal grants awarded under PL 84-660 as well as under PL 92-500.

The Combined Sewer System Data File (CSSD) is being developed as part of the 1978 Needs Survey. It contains information by authority facility number on combined sewer systems and related CSO abatement projects.

The following variables from the GICS File were examined in detail for each grant which provided funds for a combined sewer service area.

1. Grant number.
2. Project step (i.e., planning, design, or construction).
3. Action step (i.e., currently funded or proposed).
4. Amount.
5. Description.

DEVELOPMENT OF GRANT NUMBER FILE

The first step in the analysis consisted of development of a master grant number file. This file was used with the GICS File to develop the required information. The grant number file was developed from three sources of data: (1) the CSSD File, (2) the state priority list, and (3) the GICS File. The state priority list was written using an existing EPA Municipal Construction Division program and is a subset of the GICS File. The report descriptions were scanned and grant numbers were noted for each record description that mentioned combined sewer overflow pollution abatement. Also, the GICS File was examined for all grants which indicated funding for combined sewer separation. All grant numbers were then merged into a single master grant number file, listing all grants related to combined sewer systems.

PROCEDURE TO WRITE REPORT

The grant file was matched against the GICS File by grant number. Project step, action step, grant amount requested from EPA, and the first 40 characters of the project description were obtained from the GICS File for each grant number matched. If the project was previously funded, then the record and grant amount were included in this report as a current project or met need.

QUALITY OF DATA

Several problems were encountered in analyzing the data generated by the above procedure. At present, there is no way to determine how much if any of the dollar amount reported is related to CSO pollution control. We know only that combined sewers are involved to some degree in the grant. Inspection of the detailed reports by state revealed that many are not related to pollution abatement from CSO but are construction grants for dry-weather flow facilities located in combined sewered areas. Based on the project description, a decision was made as to whether or not the grant was for CSO correction. Each EPA regional office was contacted in order to verify the list of CSO correction grants and amounts identified. The final grant amounts reported here reflect any modifications or additional information supplied by the regional offices.

RESULTS

The total grant amounts by state and by step which were determined to be for CSO pollution control are given in

Table 3-1. Step 1 grants are for planning, Step 2 grants are for design, and Step 3 grants are for construction. Also reported in Table 3-1 are the CSO correction needs for each state as estimated in the 1976 Needs Survey and updated to January 1978 construction costs.

Funded grants total approximately $1.02 billion. Sixty-four percent of the total funded grant amount for combined sewer overflow control is for CSO projects in the Chicago Metropolitan Sanitary District. Based on 75% grant eligibility, these grants would generate approximately $1.36 billion in actual needs met. Thus, only about 6-1/2% of total national needs have been met.

Table 3-1
Summary of Funded Grant Amounts for CSO Pollution Control

State	Funded Amounts				Estimated Needs 1976[a]
	Step 1	Step 2	Step 3	Total	
Alabama	$ 0	$ 0	$ 0	$ 0	$ 0
Alaska	1,076	0	2,250	4,326	3,499,021
Arizona	0	0	0	0	0
Arkansas	28,491	0	7,731,119	7,759,610	54,263,221
California	3,450,000	0	33,123,750	36,573,750	446,348,285
Colorado	0	0	5,273,100	5,273,100	3,903,512
Connecticut	1,954,984	1,142,760	0	3,097,744	448,900,403
Delaware	85,120	110,420	1,592,170	1,787,710	46,050,547
District of Columbia	635,250	0	0	635,250	173,035,223
Florida	0	0	0	0	579,500
Georgia	0	0	0	0	349,120,934
Hawaii	0	0	0	0	0
Idaho	0	0	0	0	9,931,471
Illinois	2,632,145	0	650,611,130	653,243,275	2,996,603,772
Indiana	3,745,475	577,775	29,142,392	33,465,642	1,429,021,502
Iowa	1,578,070	0	0	1,578,070	105,225,610
Kansas	0	0	0	0	0
Kentucky	0	0	0	0	153,201,256
Louisiana	0	0	0	0	0
Maine	469,960	0	1,033,200	1,503,160	558,921,955
Maryland	2,745,969	1,438,756	20,130,148	24,314,873	55,006,140
Massachusetts	75,000	259,200	187,507,710	187,841,910	1,015,479,871
Michigan	69,534	0	0	69,534	1,561,701,504
Minnesota	0	0	0	0	258,917,123
Mississippi	41,250	0	81,220	122,470	0
Missouri	0	0	0	0	1,497,568,239
Montana	0	0	0	0	0
Nebraska	0	0	0	0	169,347,285
Nevada	0	421,167	5,046,950	5,468,117	16,995,576
New Hampshire	3,182,663	1,322,515	1,986,785	6,491,963	356,925,640
New Jersey					701,102,280

Table 3-1--Continued

State	Funded Amounts				Estimated Needs 1976[a]
	Step 1	Step 2	Step 3	Total	
New Mexico	$ 0	$ 0	$ 0	$ 0	$ 0
New York	0	0	12,275,492	12,275,492	3,086,910,734
North Carolina	0	0	0	0	0
North Dakota	0	0	0	0	14,878,083
Ohio	1,493,400	0	4,207,650	5,701,050	2,046,344,308
Oklahoma	0	0	0	0	0
Oregon	0	0	0	0	243,947,479
Pennsylvania	36,070	0	0	36,070	950,965,295
Rhode Island	225,000	0	11,898,303	12,123,303	306,217,072
South Carolina	0	0	0	0	0
South Dakota	0	0	1,405,080	1,405,080	1,365,302
Tennessee	0	0	0	0	212,537,420
Texas	0	0	0	0	56,539,497
Utah	0	0	0	0	0
Vermont	15,240	0	5,018,047	5,033,287	187,435,798
Virginia	0	0	3,096,970	3,096,970	283,893,573
Washington	470,407	0	122,628	593,035	395,840,224
West Virginia	190,500	97,270	0	287,770	494,384,199
Wisconsin	3,353,925	1,185,150	4,882,200	9,421,275	321,291,026
Wyoming	0	0	0	0	0
Guam	0	0	0	0	0
Puerto Rico	0	0	0	0	26,195,718
Virgin Islands	0	0	0	0	0
American Samoa	0	0	0	0	0
Pacific Trust Territories	0	0	0	0	0
Total	$26,479,529	$6,555,013	$986,168,260	$1,019,202,802	$21.17 Billion

---

[a] From 1976 Needs Survey updated to January 1978 dollars.

Chapter 4
CSO NEEDS

The objective of this phase of the investigation was to list by state combined sewer overflow needs identified in the 1977 state priority listing. These are considered CSO needs identified but not yet funded.

The sources of information and development of the grant number file are the same as described in Chapter 3.

PROCEDURE TO WRITE REPORT

The procedures used to develop the required information were the same as previously described in Chapter 4 with one exception. Instead of listing projects which were previously funded, only projects and their request grant amounts which have not as yet been funded were reported. In this manner a listing of identified but not yet funded (because of low ranking on the state priority list) projects was developed.

QUALITY OF DATA

The same considerations expressed for the data in Chapter 3 are relevant here. Again, inspection of the detailed reports by state revealed that many projects are not related to pollution abatement from CSO but are construction grants for dry-weather flow facilities located in combined sewered areas. Based on the project description, a decision was made as to whether or not the grant was for CSO correction. Each EPA regional office was contacted in order to verify the list of CSO correction grants and amounts requested. The final requested grant amounts reported here reflect any modifications or additional information supplied by the regional offices.

RESULTS

The total requested grant amount by state and by step which are considered to be for CSO pollution control are given in Table 4-1. Step 1 grants are for planning, Step 2 grants are for design, and Step 3 grants are for construction. Also reported in Table 4-1 are the CSO correction needs for each state as estimated in the 1976 Needs Survey and updated to January 1978 construction costs.

Table 4-1
Summary of Requested Grant Amounts for CSO Pollution Control

State	Requested Amounts				Estimated Needs 1976[a]
	Step 1	Step 2	Step 3	Total	
Alabama	$ 0	$ 0	$ 0	$ 0	$ 0
Alaska	0	0	0	0	3,499,021
Arizona	0	0	0	0	0
Arkansas	0	0	0	0	54,263,221
California	0	3,750,000	75,000,000	78,750,000	446,348,285
Colorado	0	21,000	1,635,000	1,656,000	3,903,512
Connecticut	1,250,000	9,610,000	461,656,000	472,516,000	448,900,403
Delaware	0	37,500	0	0	46,050,547
District of Columbia	0	45,000,000	724,500,000	769,500,000	173,035,223
Florida	0	0	0	0	579,500
Georgia	0	0	41,900,000	41,900,000	349,120,934
Hawaii	0	0	0	0	0
Idaho	0	0	0	0	9,931,471
Illinois	108,750	3,764,511	696,254,369	700,127,030	2,996,603,772
Indiana	0	0	0	0	1,429,021,502
Iowa	0	0	0	0	105,225,610
Kansas	52,500	0	0	52,500	125,126,799
Kentucky	0	0	0	0	153,201,256
Louisiana	0	0	0	0	0
Maine	0	0	1,979,000	1,979,000	558,921,955
Maryland	0	433,600	4,807,500	5,241,100	55,006,140
Massachusetts	0	12,311,199	287,280,000	299,591,199	1,015,479,871
Michigan	0	1,590,000	43,280,000	44,870,000	1,561,701,504
Minnesota	0	0	0	0	258,917,123
Mississippi	0	0	0	0	0
Missouri	0	108,000	0	108,000	1,497,568,239
Montana	0	0	0	0	0
Nebraska	0	0	0	0	169,347,285
Nevada	0	0	0	0	16,995,576
New Hampshire	0	372,000	5,100,000	5,472,000	356,925,640
New Jersey	0	0	0	0	701,102,280

Table 4-1--Continued

State	Requested Amounts				Estimated Needs 1976[a]
	Step 1	Step 2	Step 3	Total	
New Mexico	$ 0	$ 0	$ 0	$ 0	$ 0
New York	1,615,000	2,593,000	76,022,250	80,230,250	3,086,910,734
North Carolina	0	0	0	0	0
North Dakota	0	371,000	0	371,000	14,878,083
Ohio	0	500,000	9,220,000	9,720,000	2,046,344,308
Oklahoma	0	0	0	0	0
Oregon	0	0	0	0	243,947,479
Pennsylvania	0	0	0	0	950,965,295
Rhode Island	0	5,950,000	125,000,000	130,950,000	306,217,072
South Carolina	0	0	0	0	0
South Dakota	0	0	0	0	1,365,302
Tennessee	0	0	0	0	212,537,420
Texas	0	0	0	0	56,539,497
Utah	0	0	0	0	0
Vermont	0	0	0	0	187,435,798
Virginia	0	0	1,402,500	1,402,500	283,893,573
Washington	0	100,000	18,000,000	18,100,000	395,840,224
West Virginia	0	0	0	0	494,384,199
Wisconsin	0	2,900,000	3,750,000	6,650,000	321,291,026
Wyoming	0	0	0	0	0
Guam	0	0	0	0	0
Puerto Rico	159,750	182,000	0	341,750	26,195,718
Virgin Islands	0	0	0	0	0
American Samoa	0	0	0	0	0
Pacific Trust Territories	0	0	0	0	0
Total	$3,186,000	$89,593,810	$2,576,786,619	$2,669,566,429	$21.17 Billion

---

[a] From 1976 Needs Survey updated to January 1978 dollars.

Requested grants total approximately $2.67 billion. Based on 75% grant eligibility, these grants would generate approximately $3.56 billion in actual needs met. Therefore, approximately 17% of the national CSO pollution abatement needs have been identified. However, the total of met and identified needs accounts for only 23% of the total estimated in the 1976 Needs Survey.

Chapter 5
CSO CORRECTION TIME

Total national needs for control of pollution from combined sewer overflow were estimated to be $18.26 billion in January 1976 dollars. Updating this estimate to January 1978 dollars yields a total national need of approximately $21.17 billion. Previously met needs estimated and reported in Table 3-1 are approximately $1.36 billion based on 75% grant eligibility. Remaining unmet needs are therefore approximately $19.81 billion.

The time period required to correct pollution resulting from combined sewer overflow under current funding procedures is a function of the magnitude of the need which has been estimated and the annual funding level. Present funding is $4.5 billion per year for all municipal construction grants. However, that portion of the total which is invested in CSO pollution abatement is unknown since projects are funded based on the respective state's priority system. States that perceive CSO to be a major problem will give higher priority to CSO projects than will states which do not perceive the problem as major. Therefore, total correction time for any individual combined sewer service area cannot be predicted with certainty. However, correction time estimates are developed in this report on an overall basis and on a state-by-state basis. The overall estimate is developed to illustrate the effect of level of funding on CSO correction time, and the state-by-state estimates are developed to illustrate the effect of various grant allocation formulas and level of spending by the states on individual CSO correction time.

OVERALL ESTIMATE OF TIME REQUIRED TO FUND CSO POLLUTION CONTROL PROJECTS

The overall time required to fund CSO pollution control projects is illustrated on Figure 5-1. This figure defines two relationships between level of federal funding for CSO control in billion dollars per year and time required to fund present needs. The linear relationship is based on funding in January 1978 dollars. That is, federal funding is assumed to increase at a rate equal to the rate of construction cost increase such that purchasing power remains constant. The nonlinear relationship is based on the assumption that federal funding for CSO pollution abatement will remain constant regardless of increases in construction

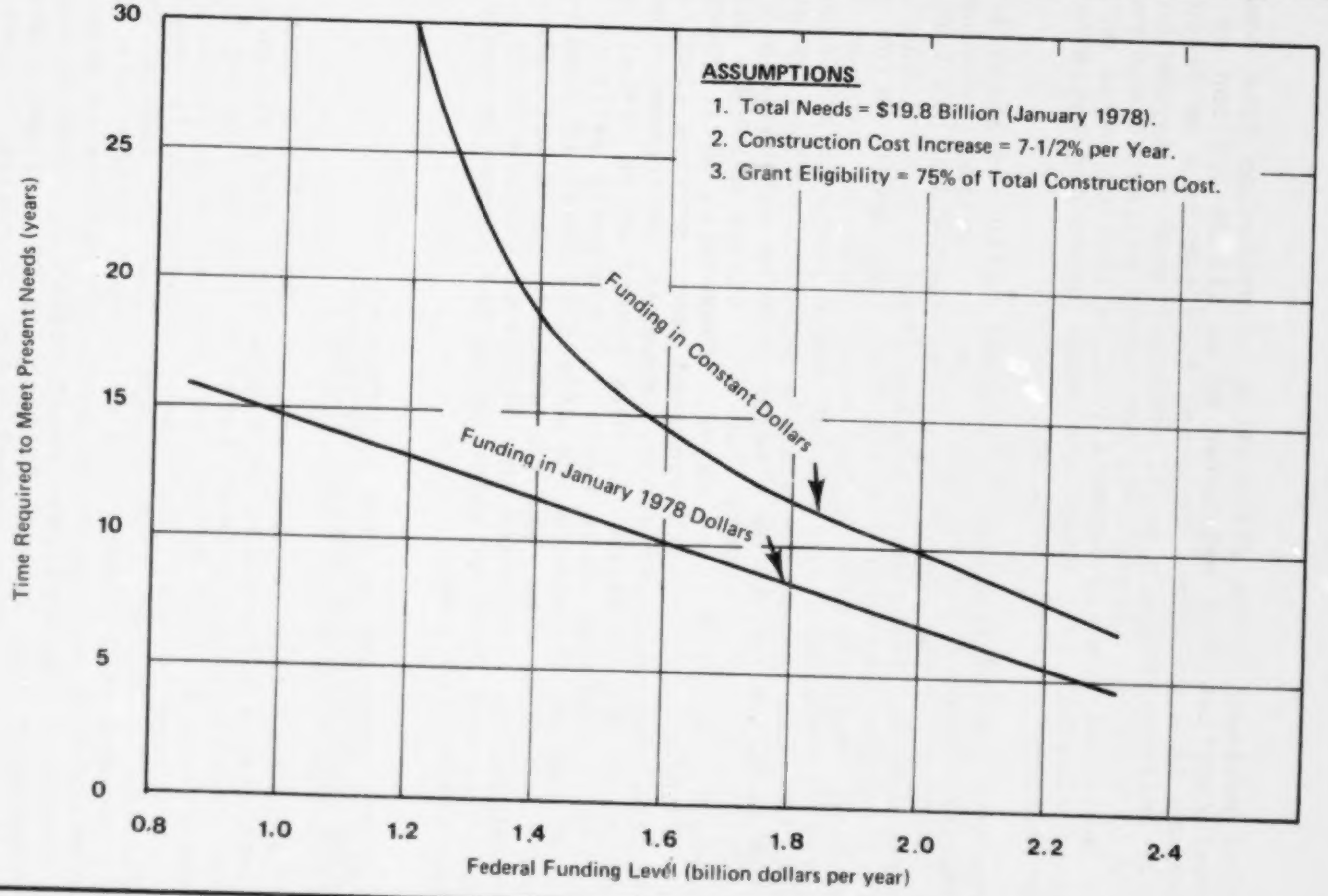


FIGURE 5-1. Estimates of CSO pollution correction times.

costs. Thus, purchasing power will decrease with time. The nonlinear relationship is also based on the assumption that construction costs will increase at a constant rate of 7-1/2% per year.

Figure 5-1 illustrates the importance of maintaining constant purchasing power if estimated needs are to be met in a reasonable period of time. For example if 1.1 billion January 1978 dollars per year of Federal Funds were allocated to CSO correction total needs would be funded in approximately 14 years. However, if funding remains a constant 1.1 billion dollars per year and if construction costs continue to increase at a rate of 7-1/2% per year, then present needs would never be met. That is, additional needs generated by construction cost increases would always be greater than needs met by actual construction in any given year.

URBAN AREAS WITH MAJOR NEEDS

Table 5-1 lists Standard Metropolitian Statistical Areas (SMSA's) which contain combined sewer service areas greater than 10,000 acres in size. Fifty-eight SMSA's meet this criterion and account for approximately 1.867 million acres of combined sewer service area or about 83% of the national total. Population served by these 58 combined sewer service areas totals approximately 30.7 million persons or 81% of the total national population served by combined sewers. Thus, the large majority of the CSO pollution problem is located in relatively few major urban areas. The remaining 17% of the combined sewer service area is scattered throughout the nation in hundreds of individual locations. The National Combined Sewer System Data File which is currently under development is a comprehensive attempt to locate and quantify all combined sewer service areas nationwide.

Direct time estimates for funding CSO pollution control projects on a city-by-city basis is not possible because construction grant funds are allocated on a state-by-state basis. However, inspection of Table 5-1 reveals that any given state has a limited number of major combined sewer service areas. Therefore, an estimate of funding time for an individual state could logically be applied to each major combined sewer system within that state.

STATE-BY-STATE ESTIMATES OF TIME REQUIRED TO FUND CSO POLLUTION CONTROL PROJECTS

Estimates of the time required for each state to fund CSO pollution control projects are developed under six sets of assumptions. The variations in the assumed conditions are related to the grant allocation formula and to the rate of spending for CSO control.

Table 5-1
SMSA's with Combined Sewer Service
Area Greater Than 10,000 Acres

State	SMSA Name	SMSA Number	Approximate Combined Sewer Service Area (Acres)	Approximate Population Served By Combined Sewers	Note
California	San Francisco	7360	28,550	731,000	2
Connecticut	Hartford	5440	20,800	275,000	1
Connecticut	New Haven	8880	16,700	179,000	1
Dist. of Columbia	Dist. of Columbia	8840	12,700	400,000	1
Georgia	Albany		12,000	76,000	1
Illinois	Chicago	1600	248,263	4,688,950	2
Illinois	St. Louis Metro	7040	16,900	47,740	2
Indiana	Anderson	0400	20,000	80,700	1
Indiana	Chicago Metro	2960	61,367	100,462	2
Indiana	Evansville	2440	15,800	142,000	1
Indiana	Fort Wayne	2760	12,320	114,000	2
Indiana	Indianapolis	3480	34,000	456,000	1
Indiana	Lafayette	3920	10,000	47,805	2
Indiana	Muncie	5280	13,686	43,000	2
Indiana	South Bend	7800	20,200	175,000	1
Kansas	Kansas City Metro		22,600	76,000	2
Kentucky	Louisville		28,800	457,450	2
Maine	Portland	6400	15,300	86,000	1
Massachusetts	Lawrence-Haverhill	4160	41,500	545,000	1
Massachusetts	Springfield	8000	32,900	254,000	1
Michigan	Detroit	2160	192,000	2,900,000	1
Michigan	Lansing	4040	10,867	85,000	2
Michigan	Saginaw	6960	11,500	103,000	1
Minnesota	Minneapolis-St. Paul	5120	26,000	326,700	1
Missouri	Kansas City	3760	36,480	292,000	2
Missouri	St. Joseph	7000	14,200	75,900	1
Missouri	St. Louis	7040	45,079	399,200	2
Nebraska	Omaha	5920	25,201	191,505	2

Table 5-1--Continued

State	SMSA Name	SMSA Number	Approximate Combined Sewer Service Area (Acres)	Approximate Population Served By Combined Sewers	Note
New Jersey	Jersey City	3640	20,572	444,098	2
New Jersey	New York City Metro	6040	22,200	1,204,000	1
New Jersey	Newark	5640	24,911	547,577	2
New Jersey	Philadelphia Metro	6160	20,300	201,000	1
New York	Albany	0160	33,860	290,456	2
New York	Binghamton	0960	15,200	145,000	1
New York	Buffalo	1280	55,566	1,154,728	2
New York	New York City	5600	107,126	5,783,000	2
New York	Rochester		17,070	328,000	2
New York	Syracuse	8160	23,530	488,086	2
New York	Utica Rome	8680	21,650	228,857	2
Ohio	Akron	0080	13,000	54,200	1
Ohio	Cincinnati	1640	73,400	778,000	1
Ohio	Cleveland	1680	46,799	151,600	2
Ohio	Columbus	1840	11,785	174,914	2
Ohio	Lima	4320	10,100	70,000	1
Ohio	Toledo	8400	19,343	204,000	2
Ohio	Youngstown	9320	13,700	172,000	1
Oregon	Portland	6440	24,200	316,000	1
Pennsylvania	Philadelphia	6160	45,600	1,926,176	2
Pennsylvania	Pittsburgh		31,500	667,000	1
Pennsylvania	Scranton		17,100	148,000	1
Rhode Island	Providence	6480	21,000	333,000	1
Tennessee	Nashville		14,700	180,000	1
Virginia	Lynchburg	4640	10,400	70,800	1
Virginia	Richmond	6760	11,500	200,000	1

Table 5-1--Continued

State	SMSA Name	SMSA Number	Approximate Combined Sewer Service Area (Acres)	Approximate Population Served By Combined Sewers	Note
Washington	Seattle	7600	37,900	463,000	1
Washington	Spokane	7840	29,429	155,439	2
West Virginia	Huntington	3400	10,400	85,000	1
Wisconsin	Milwaukee	5080	17,800	419,000	1
Total			1,867,354	30,731,343	

Notes: 1. Data from 1976 Needs Survey.
2. Data from EPA Combined Sewer System Data File.

Allocation Formulas

The following three grant allocation formulas are considered.

1. Construction grant funds will be allocated to each state under the present allocation formula.

2. Construction grant funds will be allocated to each state under a new formula. This formula proportions state allocations based on the ratio of state needs to total national needs for combined sewer overflow control (Category V) and on the ratio of state needs to total national needs for all other municipal wastewater control facilities (Categories I through IVB). The weighting factors are 20% for Category V and 80% for Categories I through IVB.

3. Construction grant funds will be allocated to each state under a new formula. This formula is identical to No. 2 above except that the weighting factors are changed to 50% for Category V and 50% for Categories I through IVB.

Rate of Spending

Once grant funds are allocated to each state, it is the state's decision as to which projects are funded. This decision is made based on a project's standing on the state's priority list. It is probable that as secondary wastewater treatment plant needs are met, combined sewer overflow pollution abatement needs will receive higher priority. The following two alternative assumptions were made concerning the rate of spending by states with CSO needs.

a. States with combined sewer systems will invest in CSO control facilities at an uniformly changing rate until a maximum of 50% of the annual allocation is invested in CSO control. The transition from the present rate of investment in CSO control facilities to the maximum rate of 50% will require 5 years.

b. The second spending assumption is identical to No. 1 above except that the maximum spending rate is reduced from 50% to 30%.

Assumptions which are common to each of the above allocation and spending alternatives are as follows.

1. Funding level for construction grants is $4.25 billion per year for current year and $5.0 billion per year thereafter. Funds are expressed in January 1978 dollars.

2. The current funding formula will be in effect from 1 October 1978 through 30 September 1981.

The allocation and spending alternatives are referenced to an alphanumeric identifier, 1a, 2a, 3a, 1b, 2b, and 3b, which represents all possible combinations of the three allocation formulas and two spending rates. The estimated time required to fund correction of CSO pollution for each state under these six alternatives is reported in Table 5-2.

The results of the analysis summarized in Table 5-2 indicate that CSO correction time will be highly variable from state to state. Average time to fund correction of CSO may vary from approximately 8.3 years to 14.3 years and maximum time to correct may vary from approximately 14 years to 40 years for the six alternatives analyzed. It also appears that the rate at which states fund CSO projects will have a greater influence on correction time than would modification of the grants allocation formula.

It should be noted that the values reported in Table 5-2 represent time required to fund CSO projects. The actual construction of these projects will require an additional 2 to 5 years in each case. Also, water pollution control facilities have an economic life ranging from 10 to 15 years for mechanical equipment and from 20 to 50 years for plants and collection systems. Therefore, the process of facilities construction for CSO pollution abatement should be realistically viewed as continuous.

Table 5-2
State-by-State Estimates of
Time Required to Fund CSO Pollution
Control Projects for Six Funding Alternatives

State	Funding Time in Years by Alternative					
	1a	2a	3a	1b	2b	3b
Alabama	0	0	0	0	0	0
Alaska	3	3	3	3	3	3
Arizona	0	0	0	0	0	0
Arkansas	4	4	4	4	4	4
California	5	5	5	5	7	7
Colorado	0	0	0	0	0	0
Connecticut	15	14	11	23	21	17
Delaware	6	8	8	9	12	12
Dist. of Columbia	19	24	14	30	38	21
Florida	0	0	0	0	0	0
Georgia	8	9	9	12	13	13
Hawaii	0	0	0	0	0	0
Idaho	4	4	4	4	4	5
Illinois	11	11	9	16	16	12
Indiana	18	15	12	27	23	17
Iowa	5	6	6	7	8	8
Kansas	7	8	8	10	12	12
Kentucky	6	6	7	8	9	10
Louisiana	0	0	0	0	0	0
Maine	25	19	13	40	29	19
Maryland	3	3	3	4	4	4
Massachusetts	13	12	11	20	17	15
Michigan	11	9	9	17	13	13
Minnesota	7	8	8	10	11	11
Mississippi	0	0	0	0	0	0
Missouri	21	19	13	33	29	19
Montana	0	0	0	0	0	0
Nebraska	12	15	12	18	23	18
Nevada	5	5	5	5	6	6
New Hampshire	15	13	11	23	19	16
New Jersey	9	10	9	13	15	14
New Mexico	0	0	0	0	0	0
New York	12	9	9	18	13	13
North Carolina	0	0	0	0	0	0
North Dakota	5	7	7	6	12	12
Ohio	13	11	10	19	16	15
Oklahoma	0	0	0	0	0	0
Oregon	9	8	8	12	11	12
Pennsylvania	10	11	10	14	16	15

Table 5-2--Continued

	Funding Time in Years by Alternative					
State	1a	2a	3a	1b	2b	3b
Rhode Island	20	14	12	32	22	17
South Carolina	0	0	0	0	0	0
South Dakota	2	2	2	2	2	2
Tennessee	7	8	8	10	11	12
Texas	3	3	3	4	4	4
Utah	0	0	0	0	0	0
Vermont	16	15	12	25	24	17
Virginia	7	8	8	10	12	12
Washington	10	8	9	14	12	12
West Virginia	11	9	9	17	13	13
Wisconsin	8	8	8	11	11	11
Wyoming	0	0	0	0	0	0
Am. Samoa	0	0	0	0	0	0
Guam	0	0	0	0	0	0
Puerto Rico	4	4	4	4	5	5
Trust Terr.	0	0	0	0	0	0
Virgin Islands	0	0	0	0	0	0
Maximum Correction Time	25	24	14	40	38	21
Average Correction Time (years)	9.78	9.36	8.26	14.20	13.64	11.84

Note: States with zero time to correct are states without combined sewer systems.

Chapter 6
COMPARISON OF ANNUAL POLLUTANT DISCHARGES

SUMMARY OF POLLUTANT DISCHARGE ANALYSIS

Pollutant loads at 15 combined sewer study sites were estimated for five parameters (BOD_5, suspended solids, total nitrogen, phosphate phosphorus, and lead) from three sources (combined sewer overflow, separate storm runoff, and wastewater treatment plant effluent). Figure 6-1 is a map locating all 15 study sites. Ten of these site studies are included in the 1978 Needs Survey. These are: Rochester, New York; Syracuse, New York; Philadelphia, Pennsylvania; Washington, D.C.; Atlanta, Georgia; Milwaukee, Wisconsin; Bucyrus, Ohio; Des Moines, Iowa; Sacramento, California; and Portland, Oregon. Five additional sites were chosen for this analysis to represent other major urban areas with combined sewer overflow problems. These five sites are: Boston, Massachusetts; New York, New York; Chicago, Illinois; Detroit, Michigan; and San Francisco, California.

Fourteen of the 15 study sites are located in urbanized areas as defined by the Bureau of the Census of the U.S. Department of Commerce. The fifteenth site, Bucyrus, Ohio, is not associated with a urbanized area. Nine of the 10 1978 Needs Survey sites (excluding Syracuse, New York) are being analyzed on a watershed/receiving water basis by simulation. The purpose of the ongoing simulations is to evaluate the water quality response of the receiving water considering all pollutant sources including combined sewer overflow.

In general, two pollutant loading comparisons are presented in Appendix B for each study site. The first is a comparison of pollutants generated by the entire urbanized area. Occasionally, two urbanized areas are applicable to a given general location, such as New York City and New York Metro New Jersey. In these cases, loading comparisons are presented for both urbanized areas resulting in a total of 18 urbanized area comparisons. Urbanized area pollutant loading estimates are based on the method presented in EPA publication No. EPA-600/2-76-275 entitled "Stormwater Management Model: Level 1 Preliminary Screening Procedures."

The second loading comparison is based on 15 studies, 10 of which are watersheds considered in the ongoing 1978 Needs Survey. The remaining five are based on previously published investigations, such as 208 studies. Generally, the 15 site studies are located within the 18 urbanized areas studied. The 15 study site data, reported in Table 6-1, are more

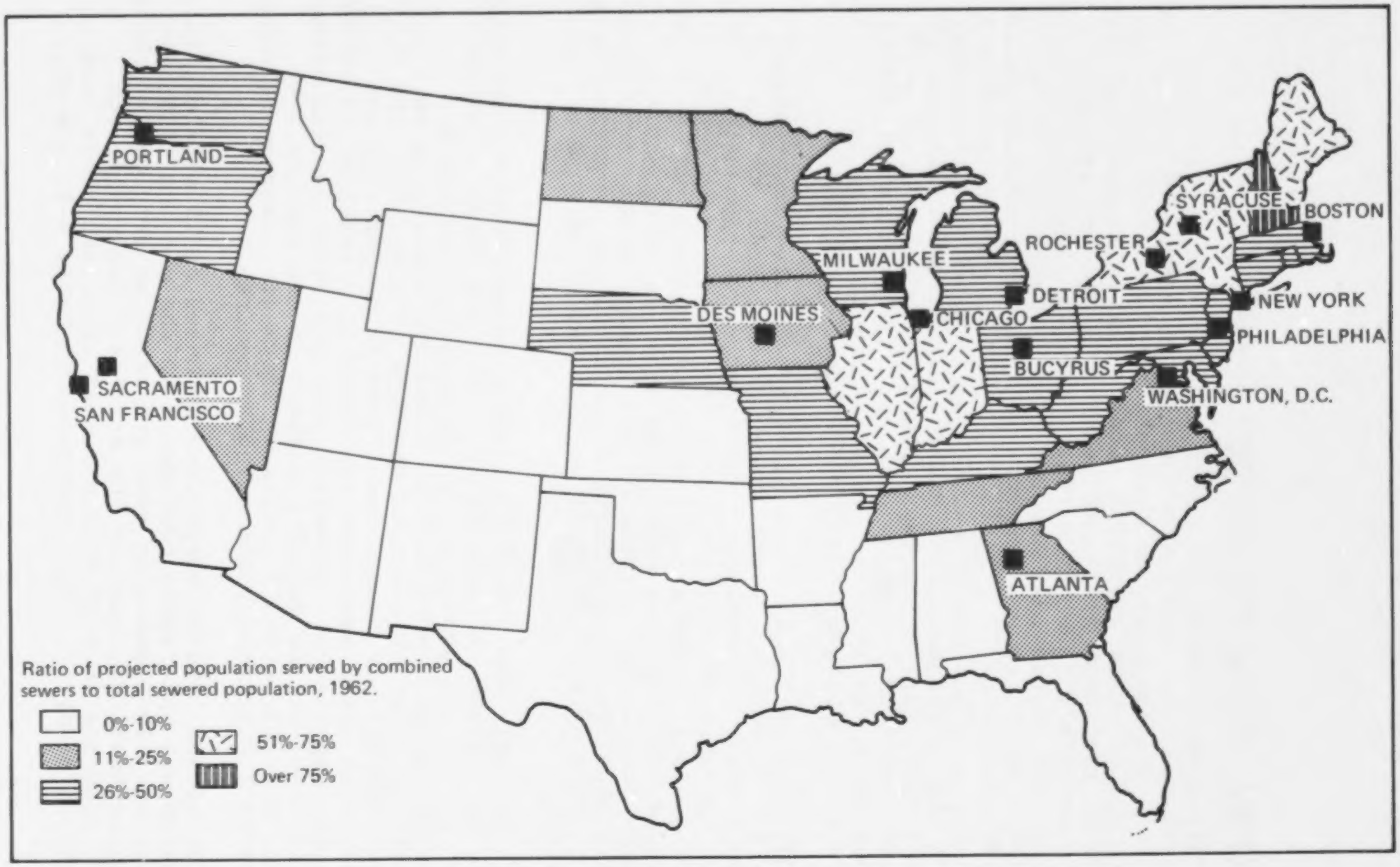

PORTLAND
SACRAMENTO
SAN FRANCISCO
DES MOINES
MILWAUKEE
CHICAGO
DETROIT
ROCHESTER
SYRACUSE
BOSTON
NEW YORK
PHILADELPHIA
BUCYRUS
WASHINGTON, D.C.
ATLANTA
Ratio of projected population served by combined sewers to total sewered population, 1962.
0%-10%
11%-25%
26%-50%
51%-75%
Over 75%

FIGURE 6-1. Location of 15 pollutant loading comparisons.

Table 6-1
Drainage Areas and Populations for 15
Study Site Pollutant Loading Comparisons

Study Site	Approximate Drainage Area (acres) Total	Approximate Drainage Area (acres) Combined Sewer	Approximate Population (1970) Total	Approximate Population (1970) Combined Sewer
Boston	24,370	24,370	875,000	875,000
New York	205,000	184,615	7,614,500	6,857,000
Rochester[a]	11,476	11,476	200,000	200,000
Syracuse[a]	13,900	9,000	175,000	147,000
Philadelphia[a]	110,000	50,000	2,076,900	944,000
Washington, DC[a]	202,521	12,396	4,000,000	389,000
Atlanta[a]	149,860	9,060	780,000	104,000
Chicago	555,000	240,000	5,500,000	4,690,000
Detroit	92,392	92,392	1,413,700	1,413,700
Milwaukee[a]	33,200	5,800	441,800	136,400
Bucyrus[a]	2,599	2,000	13,111	11,400
Des Moines[a]	49,018	4,018	255,000	117,700
San Francisco	24,637	24,637	712,000	712,000
Sacramento[a]	70,000	7,000	494,000	87,500
Portland[a]	51,394	51,394	411,000	411,000
Total	1,595,367	728,158	24,962,011	17,095,700

---

[a] Indicates site studies included in the 1978 Needs Survey.
Total Area PD = 15.65 persons/acre
Combined Sewer Area PD = 23.48 persons/acre

recent and more detailed and, therefore, probably more accurate than the data reported for the total urbanized areas in Table 6-2.

The magnitude of pollutant loads were compared for two time periods. First, the average load discharged from each source during a year was calculated in pounds per year. Second, the average annual loads were divided by the duration of a year during which that source discharged to a receiving water which gives the average event loading rate in pounds per hour.

Drainage Areas and Populations of the Study Sites

The first survey of combined sewer systems in the United States, conducted in 1967 by the American Public Works Association (APWA), estimated that 3,029,000 acres were served by combined sewers with an average population density of 11.88 persons per acre. The most recent survey of combined sewer systems in the United States, was reported in 1977 by APWA and the University of Florida, estimated that 2,248,000 acres were served by combined sewers with an average population density of 16.73 persons per acre. The 1977 survey was based on the 248 urbanized areas defined by the Bureau of the Census of the U.S. Department of Commerce in the 1970 census.

A statistical analysis of 106 urbanized areas reported in the 1977 APWA Survey found that almost 150 million people live in urbanized areas with a population density of 5.1 persons per acre. Approximately 53.8% of the urbanized area is developed and 46.2% is undeveloped. That area which is developed has an approximate land use distribution of 58.4% residential, 14.8% industrial, 8.6% commercial, and 18.2% other.

Drainage areas and populations of the 15 study sites and 18 urbanized areas considered by this study are shown in Tables 6-1 and 6-2, respectively. The total combined sewer population density of the 15 study sites is 23.48 persons per acre and of the 18 urbanized areas is 25.18 persons per acres. A comparison of the nationwide combined sewer data base to the 15 study sites and 18 urbanized areas is shown in Table 6-3. The 15 study sites comprise 32% of the total combined sewer area and 44% of the total population served by combined sewers. The 18 urbanized areas comprise 31% of the total combined sewer area and 47% of the total population served by combined sewers.

Procedure for Estimating Pollutant Loads

The magnitude of pollutant loads were compared for two time periods. First, the average load discharged from each

Table 6-2
Drainage Areas and Populations for
18 Urbanized Areas Pollutant Loading Comparisons

Urbanized Area	Approximate Drainage (acres)		Approximate Population (1970)	
	Total	Combined Sewer	Total	Combined Sewer
Boston	425,000	21,200	2,652,000	335,172
New York City	243,000	108,300	10,519,000	6,764,418
New York Metro (New Jersey)	1,309,000	6,200	5,688,000	203,608
Rochester	93,000	14,300	601,000	240,669
Syracuse	61,000	13,200	376,000	159,192
Philadelphia	450,000	10,900	3,819,000	159,031
Philadelphia Metro (New Jersey)	31,000	20,300	202,000	200,970
Washington, DC	39,000	12,700	757,000	398,780
Washington Metro (Virginia)	100,000	1,500	1,251,000	24,000
Atlanta	278,000	9,500	1,173,000	108,680
Chicago	626,000	204,900	5,714,000	4,415,595
Chicago Metro (Indiana)	191,000	32,300	1,000,000	452,523
Detroit	558,000	166,200	3,970,000	2,474,718
Milwaukee	292,000	17,800	1,252,000	418,656
Des Moines	70,000	4,000	255,000	117,680
San Francisco	436,000	24,637	2,988,000	712,000
Sacramento	156,000	5,600	634,000	69,944
Portland	171,000	24,200	825,000	316,052
Total	5,529,000	697,737	43,676,000	17,571,688

Source: "Nationwide Evaluation of Combined Sewer Overflows and Urban Stormwater Discharges, Volume II: Cost Assessments and Impacts." EPA-600/2-77-064. March 1977.
Total Area PD = 7.90 persons/acre
Combined sewer area PD = 25.18 persons/acre

Table 6-3
Summary of Combined Sewer Drainage Areas and Populations

	Total Area Studied (acres)	Total Combined Sewer Area (acres)	Combined Sewer Population	Combined Sewer Population Density (persons/acre)
APWA, 1967	6,529,300	3,029,000	36,000,000	11.88
APWA and UF, 1977	29,037,000	2,248,000	37,606,000	16.73
18 urbanized areas (see Table 6-2)	5,529,000	697,737	17,571,688	25.18
15 study sites (see Table 6-1)	1,595,367	728,158	17,095,700	23.48

source during a year was calculated in pounds per year. Secondly, the average annual loads were divided by the duration of a year during which that source discharged to a receiving water, yielding the average event load in pounds per hour. In the case of WWTP effluent, the duration of discharge is a continuous event for 8,760 hours per year, while combined sewer overflow and storm runoff are intermittent sources which discharge from 200 to 1,300 hours per year.

Results of the average annual and event load calculations are presented in the study site discussions reported in Appendix B. In the discussion of study site results, any pollutant source which contributes greater than 33% of the total load during the period of comparison is termed major.

Average Annual Loads. As previously discussed, two independent methods were used for estimating the magnitudes of average annual pollutant loads. The first method is presented in EPA publication No. EPA-600/2-76-275 entitled "Stormwater Management Model: Level 1 Preliminary Screening Procedures."

Average areal loading rates from intermittent urban runoff and CSO in pounds per acre per year are based on urbanized area population density data by sewer type, i.e., combined, separate, or nonsewered, and average annual rainfall. The equations used for these calculations are shown in Table 6-4. The total average annual loading rate from intermittent combined sewer overflow or urban runoff in pounds per year is then found by multiplying the areal loading rate times the drainage area of that source. Average areal loading rates from continuous WWTP effluent in pounds per acre per year are based on a municipal wastewater flow of 100 gallons per capita per day, secondary wastewater treatment plant effluent concentrations as defined in Table 6-5, and the urbanized area population density. The average annual discharge from continuous WWTP effluent in pounds per year is then found by multiplying the continuous source areal loading rate times the urbanized area developed area.

The second method uses 1978 Needs Survey data or previously published reports to estimate the average annual loads from intermittent urban runoff and CSO. The 10 combined sewer site studies included in the 1978 Needs Survey were simulated using the Continuous Stormwater Pollution Simulation System (CSPSS) which calculates a continuous trace of intermittent urban runoff and generates annual loads tributary to the relevant receiving water from combined sewer overflow and urban storm runoff. Average annual loads for WWTP effluent at these 10 site studies are based on the average daily flow and an assumed level of secondary treatment effluent, as

Table 6-4
Stormwater Average Areal Load Equations

Parameter	Combined Sewer Area	Separate or Nonsewered Area
BOD₅	$M = (1.92)P(0.142 + 0.218\ PD_d^{0.54}) + (1.89)P$	$M = (0.467)P(0.142 + 0.218\ PD_d^{0.54}) + (0.457)P$
SS	$M = (39.25)P(0.142 + 0.218\ PD_d^{0.54}) + (25.94)P$	$M = (9.52)P(0.142 + 0.218\ PD_d^{0.54}) + (6.29)P$
TN	$M = (0.315)P(0.142 + 0.218\ PD_d^{0.54}) + (0.28)P$	$M = (0.0765)P(0.142 + 0.218\ PD_d^{0.54}) + (0.068)P$
PO₄	$M = (0.0812)P(0.142 + 0.218\ PD_d^{0.54}) + (0.071)P$	$M = (0.0196)P(0.142 + 0.218\ PD_d^{0.54}) + (0.0172)P$
PB	$M = (0.0126)P(0.142 + 0.218\ PD_d^{0.54}) + (0.0124)P$	$M = (0.0126)P(0.142 + 0.218\ PD_d^{0.54}) + (0.0124)P$

Source: Heaney, J. P. et al. *Nationwide Evaluation of Combined Sewer Overflows and Urban Storm-water Discharges*, EPA-600/2-77-064. March 1977.

Notes: M = Areal loading rate, $\frac{\text{lb}}{\text{acre-year}}$.
P = Average annual rainfall, inches.
PD_d = Population density of the developed sewer area, capita/acre.

These equations are based on a typical developed land use distribution of 58.4% residential, 14.8% industrial, 8.6% commercial, 18.2% other, and 46.2% undeveloped.

shown in Table 6-5 unless a higher quality effluent is known to exist. Data for the additional five study sites not included in the 1978 Needs Survey were taken from wastewater management facilities plans or 208 studies that are referenced in Appendix B. In the case where a particular annual pollutant loading rate, e.g., lead, had not been estimated, ratios of the particular parameter to BOD_5 as shown in Table 6-6 were used to estimate the missing pollutant load.

Average Event Loads. Average event pollutant loading rates were determined by dividing the average annual pollutant discharge by the approximate average duration of runoff for the watershed of interest. Thus, an intermittent event factor, the reciprocal of the average annual runoff duration in hours per year, is multiplied by the average annual load in pounds per year to give the average intermittent event loading rate in pounds per hour. WWTP effluent average annual loads are multiplied by a continuous event factor, which is the reciprocal of 8,760 hours per year, to give the average continuous event loading rate in pounds per hour.

RESULTS

Nationwide

A nationwide comparison of annual pollutant discharges from combined sewer overflow and secondary wastewater treatment plant (WWTP) effluent is shown in Table 6-7. These estimates of annual pollutant discharges were calculated using the equations shown in Table 6-4 for an average annual rainfall of 33.4 inches on the nationwide combined sewer area of 2,248,000 acres (3,512.7 square miles) with a population density of 16.73 persons per acre, and on the total U.S. urbanized area of 29,037,000 acres (45,370.3 square miles) with a population density of 5.1 persons per acre. This calculation does not give an exact estimate of the annual pollutant discharges since site specific variations in population density, rainfall, and land use distributions are not considered. However, these estimates will give a reasonable comparison of nationwide pollutant discharges.

The comparison in Table 6-7 shows that BOD_5 annual discharges are approximately the same from combined sewer overflow and secondary WWTP effluent. The annual discharges of SS and Pb are approximately 15 and 14 times higher from combined sewer overflow than from secondary WWTP effluent. In addition, the annual discharges of PO_4 and TN from secondary WWTP effluent are approximately 4 and 7 times the discharges from combined sewer overflow, respectively.

Table 6-5
Secondary Wastewater Treatment Plant Effluent Concentrations for the 1978 Needs Survey

Parameter	Secondary WWTP Effluent (mg/1)
BOD_5	30
SS	30
TN	30
PO_4	4
Pb	0.04

Table 6-6
BOD_5 Ratios for Stormwater Loads

Parameter	Ratio
Combined sewer ratios	
SS	17.24 BOD_5
TN	0.1646 BOD_5
PO_4	0.04085 BOD_5
Pb	0.006564 BOD_5
Separate and nonsewer ratios	
SS	17.24 BOD_5
TN	0.1646 BOD_5
PO_4	0.04085 BOD_5
Pb	0.027064 BOD_5

Note: $\frac{BOD_5 \text{ Combined}}{BOD_5 \text{ Separate}} = \frac{3.8816}{0.941462} = 4.12$

Table 6-7
Nationwide Comparison of Annual Discharges From Combined Sewer Overflow and Secondary Wastewater Treatment Plant Effluent

Parameter	Combined Sewer Overflow		Secondary Wastewater Treatment Plant Effluent		
	Average Concentration (mg/l)	Average Annual Discharge (million lb/year)	Average Concentration (mg/l)	Combined Sewer Area (million lb/year)	U.S. Urbanized Area (million lb/year)
BOD_5	115	306	30	344	1,353
SS	370	5,310	30	344	1,353
TN	9-10	48	30	344	1,353
PO_4	1.9	12.3	4	45.8	180
Pb	0.37	2.01	0.04	0.457	1.804

Note: Based on a total U.S. urbanized area of 29,037,000 acres (45,298 square miles) with a population density of 5.1 persons per acre, a total combined sewer area of 2,248,000 acres (3,507 square miles) with a population density of 16.73 persons per acre, average annual rainfall of 33.4 inches, and a municipal wastewater flow of 100 gpcpd.

A comparison of annual pollutant discharges nationwide does not give adequate representation to the severity of combined sewer overflow pollution. In densely populated urban areas, combined sewer overflow is generally located on relatively small reachs of a receiving water and the occurrence of CSO eliminates water use where the most people live. In addition, when flooding occurs in a combined sewer area, a public health problem can result due to sewage flooding of streets and basements. The fecal coliform content, and indication that pathogenic organisms may also be present, can be several thousand organisms per 100 ml of sample.

Short-term impacts of the combined sewer overflow on the receiving water are generally caused by suspended solids (SS), biochemical oxygen demand (BOD), and coliform bacteria, while long-term impacts from combined sewer overflow are generally caused by total nitrogen (TN) and phosphate-phosphorus (PO_4). However, combined sewer overflow problems are very site specific and require a detailed investigation of the existing collection system, receiving water uses, and receiving water impacts. Since combined sewer overflow generally occurs between 2% and 15% of the time, there is a significant potential for severe shock loading effects of the receiving water.

15 Study Sites

A summary of annual and event discharges from 18 urbanized areas with a combined sewer area of 697,737 acres (1,090.2 square miles) and a population density of 26.18 persons per acre is shown in Table 6-8. Combined sewer overflow and storm runoff are found to be a major source of annual SS and Pb discharges, while secondary WWTP is shown to be a major source of annual BOD_5, TN, and PO_4 discharges. On an event basis, combined sewer overflow and storm runoff are found to be a major source of BOD_5, SS, and Pb discharges, while secondary WWTP is shown to be a major source of event TN and PO_4 discharges.

Appendix B presents results of the Stormwater Management Model (SWMM) Level I analysis performed on 15 U.S. combined sewer study sites including description of the combined sewer problem, the annual and event pollutant discharges, and sources of further information.

The relationship between relative combined sewer service area and the percentage of total pollutant discharge contributed by combined sewer overflow for the 18 urbanized areas are shown in Figures 6-2 through 6-6. Although the data represented by these curves were quite scattered, a clear difference between event and annual discharges and between the five pollutants is indicated. If the percentage

Table 6-8
Percentage of Sites Where Indicated Source
Contributes More Than 33% of the Total Pollutant Discharge

Parameter	CSO		Storm Runoff		Secondary Wastewater Treatment Plant Effluent	
	Annual	Event	Annual	Event	Annual	Event
BOD_5	28	67	22	61	89	0
SS	67	67	56	61	0	0
TN	0	61	0	39	100	67
PO_4	0	56	0	33	100	78
Pb	33	33	94	94	0	0

Note: Based on pollutant loading comparison for 18 urbanized areas.

of the total area served by combined sewers is known, it is possible to estimate the percentage of the annual discharge (dashed lines) or event discharge (solid lines) contributed by combined sewer overflow. For example, if 50% of an urban drainage area is served by combined sewers, then approximately 40% of the annual BOD_5 discharge and 80% of the event BOD_5 discharge are contributed by combined sewer overflow (see Figure 6-2).

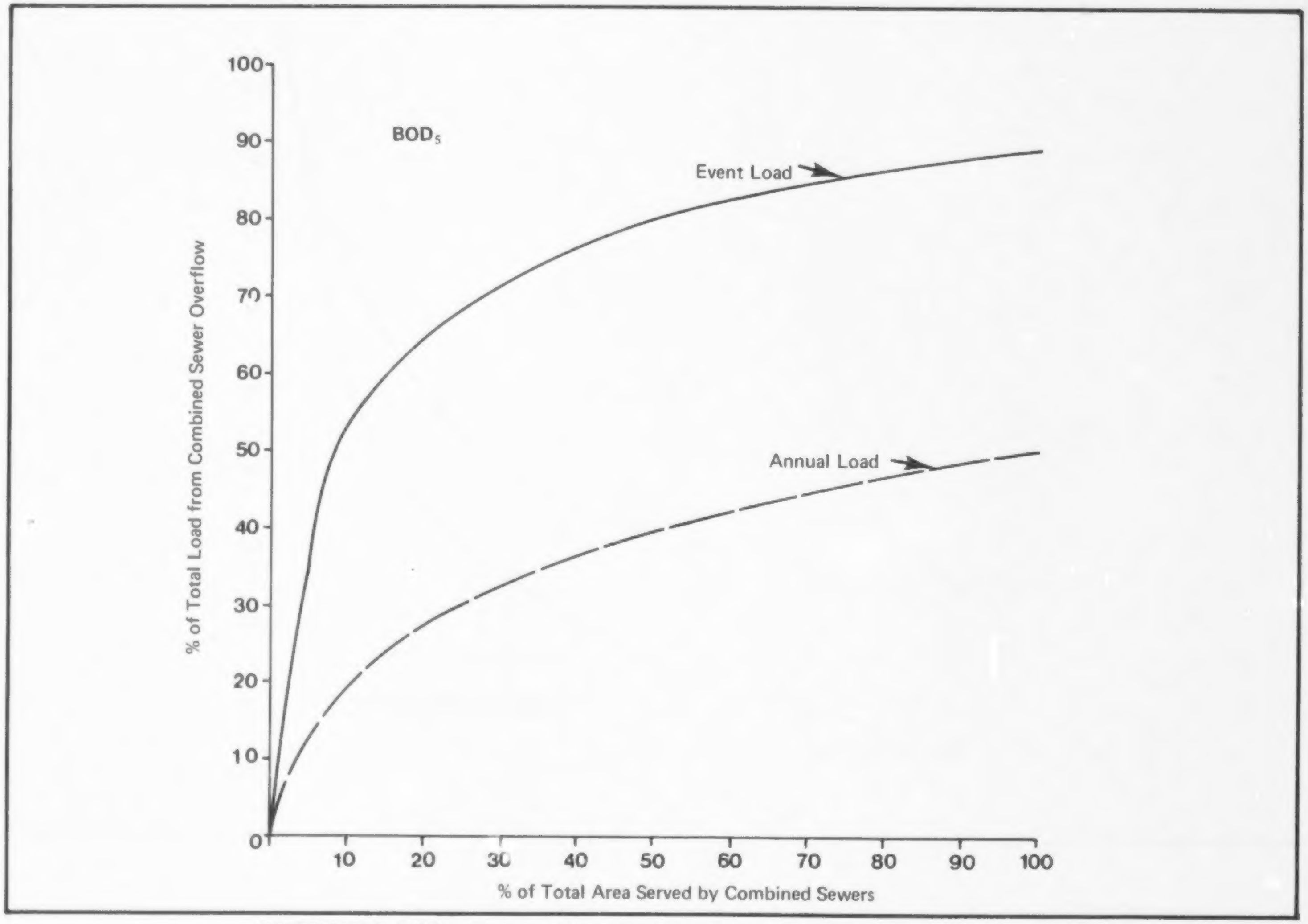


FIGURE 6-2. BOD$_5$ discharge from combined sewer overflow versus combined sewer area.

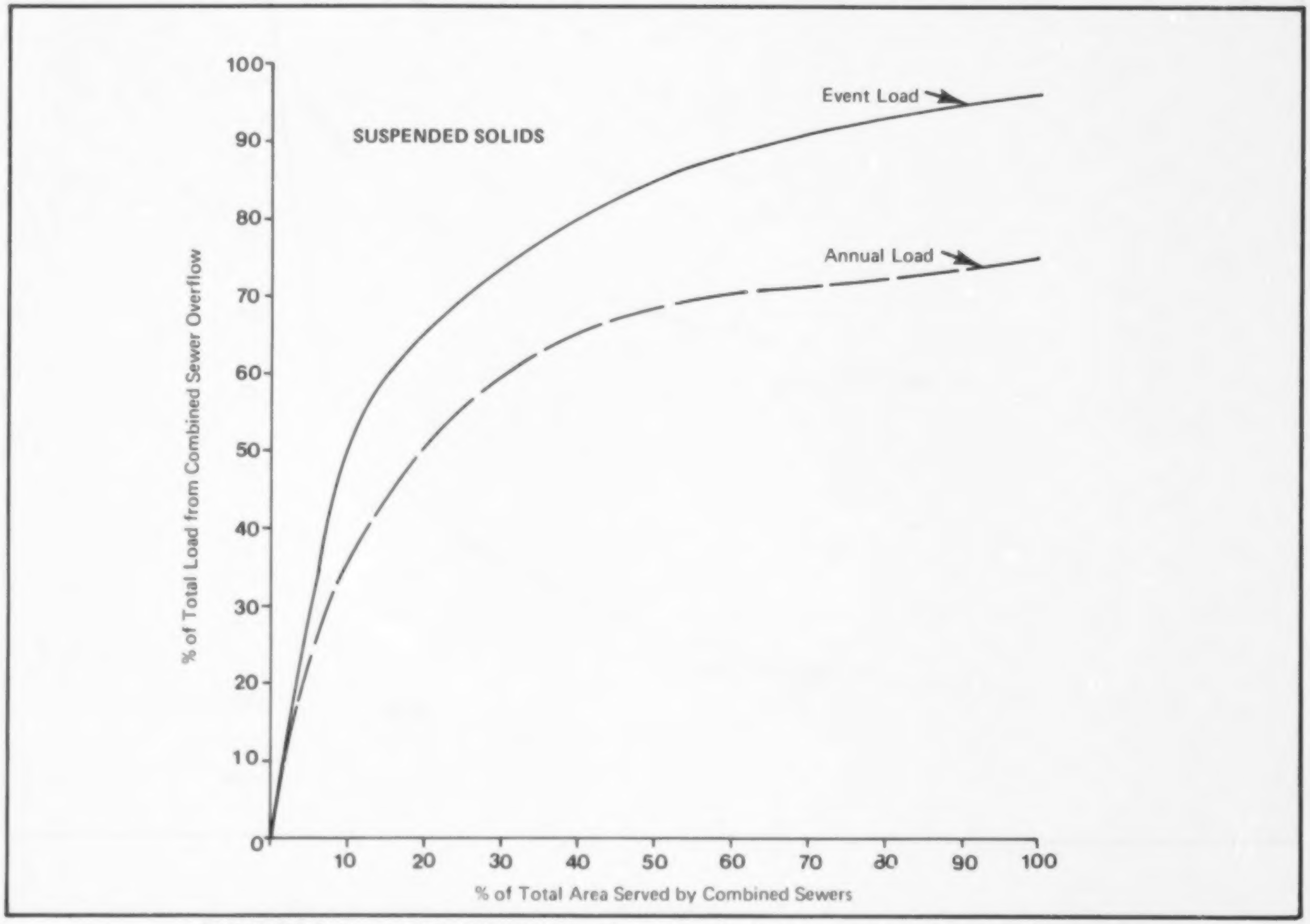


FIGURE 6-3. Suspended solids discharge from combined sewer overflow versus combined sewer area.

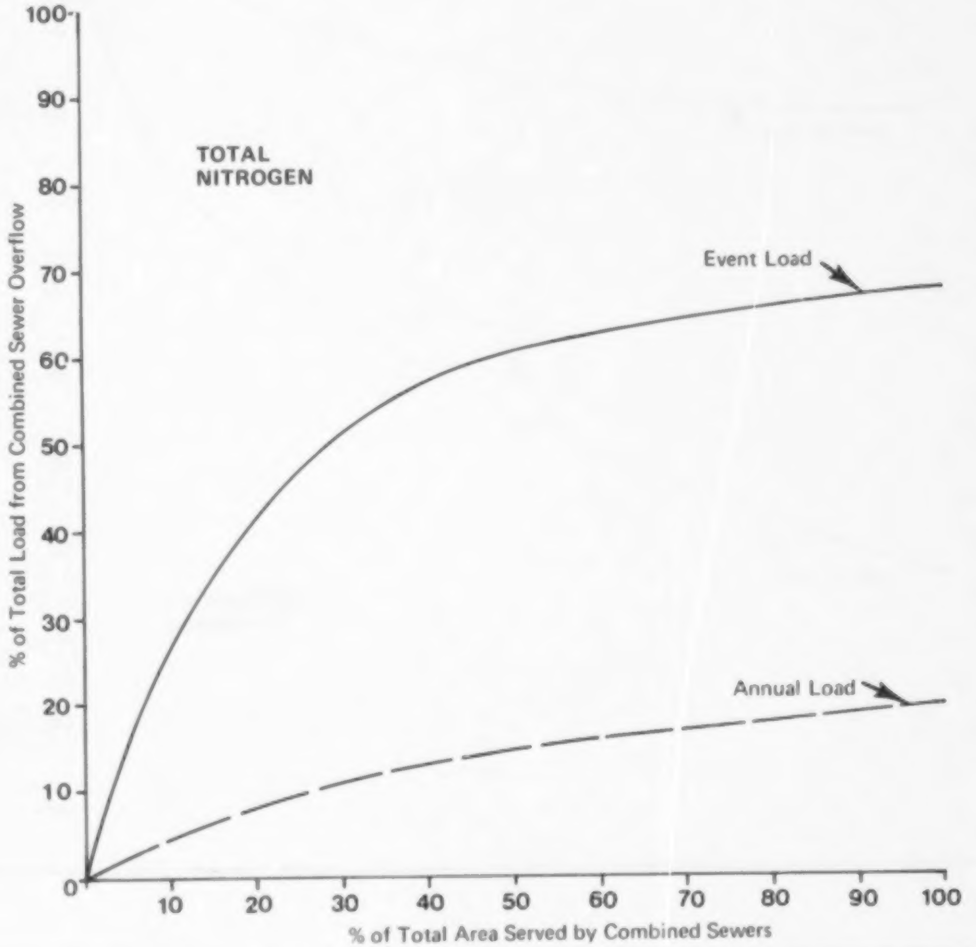


FIGURE 6-4. Total nitrogen discharge from combined sewer overflow versus combined sewer area.

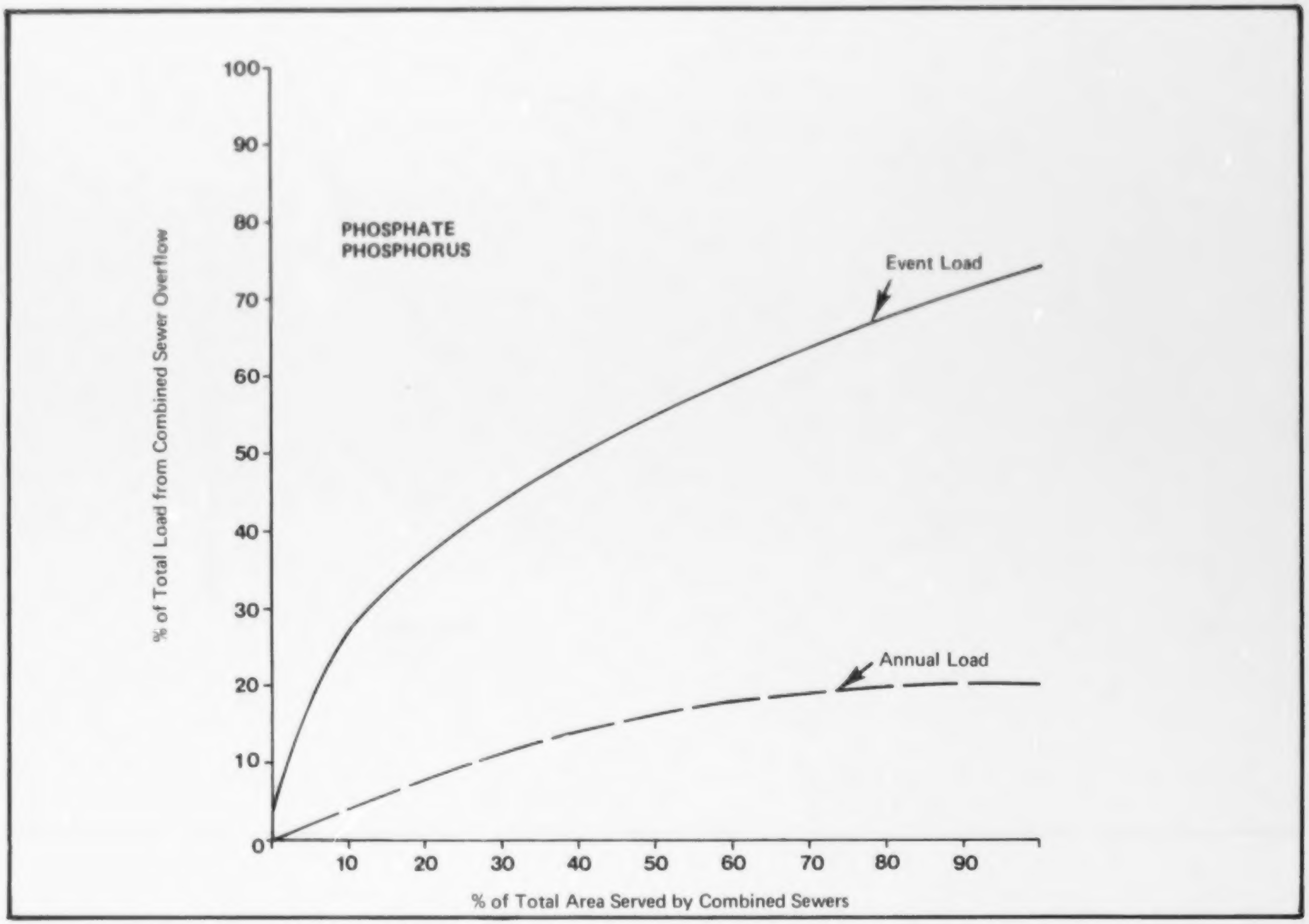


FIGURE 6-5. Phosphate phosphorus discharge from combined sewer overflow versus combined sewer area.

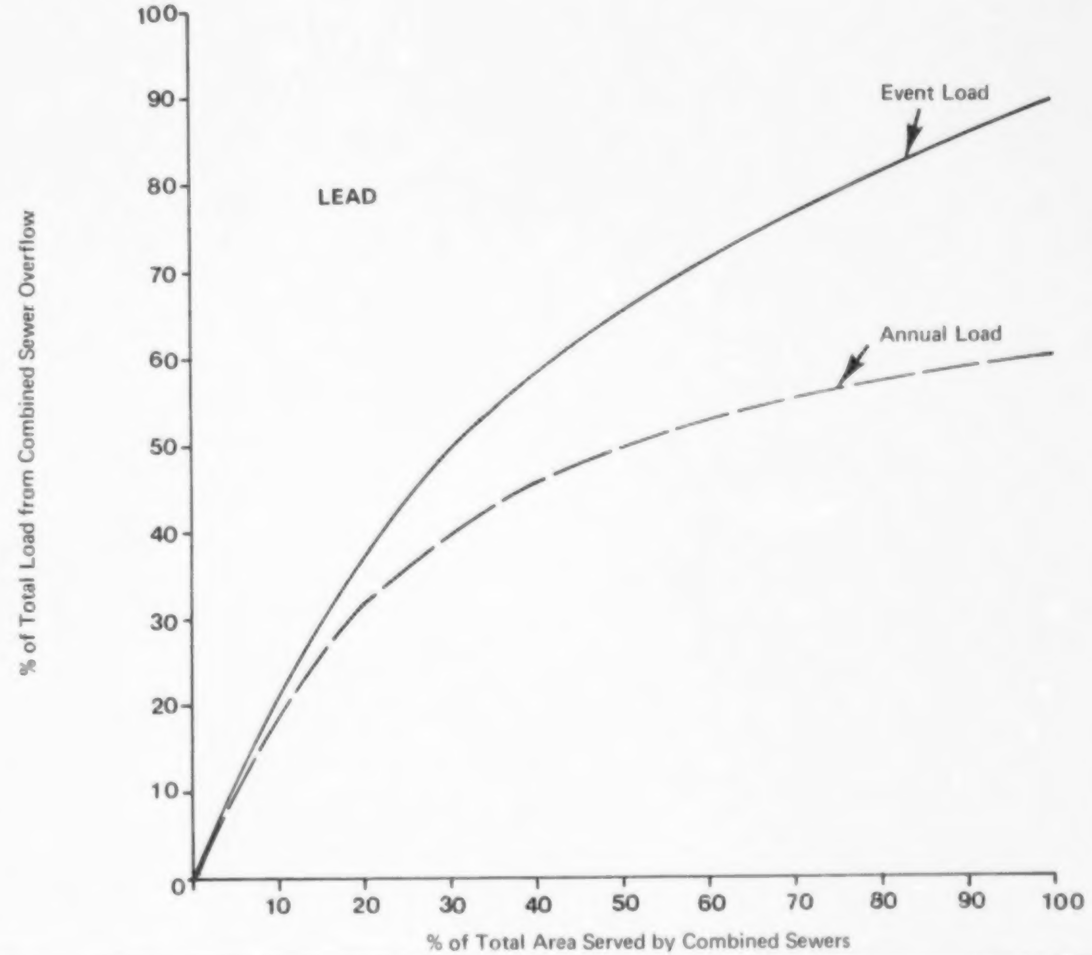


FIGURE 6-6. Lead discharge from combined sewer overflow versus combined sewer area.

Chapter 7
TECHNOLOGICAL ALTERNATIVES FOR COMBINED SEWER OVERFLOW CONTROL

INTRODUCTION

Alternatives for the control of combined sewer overflow must be adaptable to highly variable operating conditions and/or adaptable as dual wet- and dry-weather treatment facilities. They must also be flexible to site-specific problems and subject to reliable automatic operation. Funding for research, development, and demonstration of combined sewer overflow control technology during the past 10 years has been approximately $45 million which is less than 2/10 of 1% of the total $21.16 billion of estimated needs for control of combined sewer overflow.

Most of the information presented in this chapter was taken from research reports published by the EPA Municipal Environmental Research Laboratory, Office of Research and Development, in the *Environmental Protection Technology Series*. Two EPA compendium reports summarize the state-of-the-art in stormwater control technology. They are entitled:

1. "Urban Stormwater Management and Technology: An Assessment." EPA-670/2-74-040. December 1974.

2. "Urban Stormwater Management and Technology: Update and User's Guide." EPA-600/8-77-014. September 1977.

Source control, collection system control, and treatment alternatives for combined sewer overflow are defined in the first section of this chapter. A detailed description of each alternative including advantages, disadvantages, and sources of additional information are presented in Appendix C. This chapter provides cost-effectiveness data and the expected range of feasible BOD removal for each control alternative. Energy consumption in kilowatt hours per million gallons treated is also presented for several treatment options. The last section presents a comparison of cost effectiveness for seven different combined sewer overflow treatment systems, each with a design capacity of 25 mgd.

PROCESS DEFINITIONS

Source Controls

Street Cleaning. The major objective of municipal street cleaning is to enhance the aesthetic appearance of streets by periodically removing the surface accumulation of litter, debris, dust, and dirt. Common methods of street cleaning are manual, mechanical broom sweepers, vacuum sweepers, and street flushing. However, as currently practiced, street flushing does not remove pollutants from stormwater but merely transports them from the street into the sewers. Sweeping streets in combined sewer watershed will have a small impact on the BOD_5 discharge since most of the BOD_5 load is located in the sewers and not on the streets. As a result, streetsweeping will be more effective from a BOD removal viewpoint for a watershed served by separate sewers than for a watershed served by combined sewers.

Combined Sewer Flushing. The major objective of combined sewer flushing is to resuspend deposited sewage solids and transmit these solids to the dry-weather treatment facility before a storm event flushes them to a receiving water. Combined sewer flushing consists of introducing a controlled volume of water over a short duration at key points in the collection system. This can be done using external water from a tanker truck with a gravity or pressurized feed or using internal water detained manually or automatically. A recent feasibility study of combined sewer flushing indicates that manual flushing using an external pressurized source of water is most effective. Combined sewer flushing is most effective when applied to flat collection systems. It may also be applied in conjunction with upstream storage and downstream swirl concentrators, followed by disinfection.

Catch Basin Cleaning. The major objective of catch basin cleaning is to reduce the first flush of deposited solids in a combined sewer system by frequently removing accumulated catch basin deposits. Methods to clean catch basins are, manual, eductor, bucket, and vacuum. Less than 45% of municipalities in the United States uses mechanical methods.

The role of catch basins in newly constructed sewers is marginal due to improvements in street surfacing and design methods for providing self-cleaning velocities in sewers. Catch basins should be used only where there is a solids-transporting deficiency in the downstream sewers or at a specific site where surface solids are unusually abundant; however, many existing combined sewers have catch basins.

Collection System Controls

Existing System Management. The major objective of collection system management is to implement a continual remedial repair and maintenance program to provide maximum transmission of flows for treatment and disposal while minimizing overflow, bypass, and local flooding. It requires an understanding of how the collection system works and patience to locate unknown malfunctions of all types, poorly optimized regulators, unused in-line storage, and pipes clogged with sediments in old combined sewer systems.

The first phase of analysis in a sewer system investigation is an extensive inventory of existing data and mapping of flowline profiles. This information is then used to conduct a detailed physical survey of regulator and storm drain performance. This type of sewer system inventory and study should be the first objective of any combined sewer overflow pollution abatement project.

Flow Reduction Techniques. The major objective of flow reduction techniques is to maximize the effective collection system and treatment capacities by reducing extraneous sources of clean water. Infiltration is the volume of ground water entering sewers through defective joints; broken, cracked, or eroded pipe; improper connections; and manhole walls. Inflow is the volume of any kind of water discharged into sewerlines from such sources as roof leaders, cellar and yard drains, foundation drains, roadway inlets, commercial and industrial discharges, and depressed manhole covers. Combined sewers are by definition intended to carry both sanitary wastewater and inflow. Therefore, flow reduction opportunities are limited. Typical methods for reducing sewer inflow are by discharging roof and areaway drainage onto pervious land, use of pervious drainage swales and surface storage, raising depressed manholes, detention storage on streets and rooftops, and replacing vented manhole covers with unvented covers.

Sewer Separation. Sewer separation is the conversion of a combined sewer system into separate sanitary and storm sewer systems. Separation of municipal wastewater from storm water can be accomplished by adding a new sanitary sewer and using the old combined sewer as a storm sewer, by adding a new storm sewer and using the old combined sewer as a sanitary sewer, or by adding a "sewer within a sewer" pressure system.

Swirl and Helical Concentrators. The major objective of swirl and helical concentrators is to regulate both the quantity and quality of storm water at the point of overflow. Solids separation is caused by the inertia differential which results from a circular path of travel. The flow is separated into a large volume of clear overflow and a concentrated low volume of waste that is intercepted for treatment at the wastewater treatment plant. In addition to regulation of combined sewer flow, they can provide high-rate primary treatment for solids removal. A major attribute of the swirl concentrator is the relatively constant treatment efficiency over a wide range of flow rates (a fivefold flow increase results in only about a 25% efficiency reduction) and the absence of mechanical parts which use energy unless input or output pumping is required. Swirl and helical bend concentrators have been modeled and, in several cases, demonstrated for various processes including treatment and flow regulation, primary treatment, and erosion control.

Remote Monitoring and Control. The major objective of remote monitoring and control on a combined sewer collection system is to remotely observe the sewer and treatment capacities so that the most effective use of inline storage is obtained with a minimum of severe overflow. A prerequisite for this alternative is a large collection system with the potential for inline storage. Three components are generally added to the existing collection system: a data gathering system for reporting rainfall, pumping rates, treatment rates, and regulator positions; a central computer processing center, and a control system to remotely manipulate gates, valves, regulators, and pumps. The capital costs, operation and maintenance costs, and effectiveness depend on the hydraulic characteristics of the system of concern and thus are very site-specific.

Fluidic Regulations. The major objective of fluidic combined sewer overflow regulation is to provide dynamic control at the site of overflow without a complex operational system. They are self-operated by using a venturi pressure gradient which senses the dry-weather interceptor sewer capacity before allowing combined storm water to overflow. New fluidic regulator capital costs are estimated to be 10% greater than conventional static regulators.

Polymer Injection. The primary objective of polymer injection to sewer flow is to increase the flow capacity of an existing sewer by reducing the turbulent friction. It is most applicable as an interim solution to infiltration problems of sanitary sewers since they respond slowly over a long period to rainfall-induced infiltration. A rapid short duration flow increase, such as that occurring in combined sewers, will generally exceed the capacity of polymer friction reduction. Polymers used are water soluble, have a high molecular weight and a large length-to-diameter ratio, and are not toxic or harmful if swallowed.

Treatment Facilities

Off-Line Storage. The major objective of off-line storage is to contain combined sewer overflow for controlled release into treatment facilities. Off-line storage provides a more uniform constant flow and thus reduces the size of treatment facilities required. Off-line storage facilities may be located at overflow points or near dry-weather or wet-weather treatment facilities. A major factor determining the feasibility of using off-line storage is land availability. Operation and maintenance costs are generally small, requiring only collection and disposal costs for sludge solids, unless input or output pumping is required.

Sedimentation. The major objective of sedimentation is to produce a clarified effluent by gravitational settling of the suspended particles that are heavier than water. It is one of the most common and well-established unit operations for wastewater treatment. Sedimentation also provides storage capacity, and disinfection can be effected concurrently in the same tank. It is also very adaptable to chemical additives such as lime, alum, ferric chloride, and polymers which provide higher suspended solids, BOD, nutrients, and heavy metals removal.

Dissolved Air Flotation. The major objective of dissolved air flotation (DAF) is to achieve suspended solids removal in a shorter time than conventional sedimentation by attaching air bubbles to the suspended particles. The principal advantage of flotation over sedimentation is that very small or light particles that settle slowly can be removed more completely and in a shorter time. Capital costs for DAF are moderate; however, operating costs are relatively high due to the energy required to compress air and release it into the flotation basin and due to the greater skill required by operators. Chemical additives are also useful to improve process efficiencies of BOD and SS removals and to obtain nitrogen and phosphorus removals.

Screens. The major objective of screening is to provide high-rate solids/liquid separation for combined sewer particulate matter. Four basic screening devices have been developed to serve one of two types of applications. The microstrainer is a very fine screening device designed to be the main treatment process of a complete system. The other three devices, drum screens, rotary screens, and static screens, are basically pretreatment devices designed to remove coarse materials. BOD removal efficiencies are approximately 15% for pretreatment screens and up to 50% for microstrainers. For all screens, removal performance tends to improve as influent suspended solids concentrations increase due to the relatively constant effluent concentrations.

In addition, screens develop a mat of trapped particles which act as a strainer retaining particles smaller than the screen aperture. Chemical additives can be used to improve process removal efficiencies. The use of screens in series does not show any advantage over the use of a single screen. Microstrainers break up solid particles and expose greater numbers of bacteria in the effluent to disinfection.

High-Rate Filtration. The major objective of high-rate filtration (HRF) is to capture suspended solids and other pollutants in a fixed bed dual media filter (a bed of anthracite coal is usually above sand filter media). Filtration is one step finer than screening. Solids are usually removed by one or more of the following mechanisms: straining, impingement, settling, and adsorption. Filtration has not been used in wastewater treatment because of rapid clogging due to compressible solids. Combined sewer overflow contains a larger fraction of discrete, noncompressible solids which can easily be washed from the filter media by periodic backwashing. HRF has been developed over the past 15 years for a variety of treatment applications, mainly for industrial wastewater treatment.

High Gradient Magnetic Separation. The major objective of high gradient magnetic separation (HGMS) is to bind suspended solids to small quantities of a magnetic seed material (iron oxide called magnetite) by chemical coagulation and then pass them through a high gradient magnetic field for removal. Magnetic separation techniques have been used since the 19th century to remove tramp iron and to concentrate iron ores. Solids are trapped in a magnetic matrix which must be cyclically back-flushed like screens and filters.

Chemical Additives. The major objective of using chemical additives is to provide a higher level of treatment than is possible with unaided physical treatment processes (sedimentation, dissolved air flotation, high rate filtration, and high gradient magnetic separation). Chemicals commonly used are lime, aluminum or iron salts, polyelectrolytes, and combinations of these chemicals. There is no rational method for predicting the chemical dose required. Jar tests are used for design purposes; however, field control is essential since the chemical composition of combined sewer overflow is highly variable.

Carbon Adsorption. The major objective of carbon adsorption is to remove soluble organics as part of a complete physical-chemical treatment system that usually includes preliminary treatment, sedimentation with chemicals, filtration, and disinfection. Carbon contacting can be done using either granular activated carbon in a fixed or fluidized bed or powdered activated carbon in a sedimentation basin. Periodic backwashing of the fixed bed must be provided, even if prefiltration is used, because suspended solids will accumulate in the bed. Application of carbon adsorption is well suited to advanced waste treatment of sanitary sewage. However, the feasibility of application to combined sewer overflow is dependent upon the effluent quality objectives, the degree of preunit flow attenuation, and the ability to obtain dual dry- and wet-weather use of treatment facilities.

Biological Treatment. The major objective of biological treatment is to remove the nonsettleable colloidal and dissolved organic matter by biologically converting them into cell tissue which can be removed by gravity settling. Several biological processes have been applied to combined sewer overflow treatment including contact stablization, trickling filters, rotating biological contactors, and treatment lagoons. Biological treatment processes are generally categorized as secondary treatment processes. These processes are capable of removing between 70% and 95% of the BOD_5 and suspended solids from waste flows at dry-weather flow rates and loadings. An operational problem when treating intermittent wet-weather storm events by biological processes is maintaining a viable biomass. Biological systems are extremely susceptible to overloaded conditions and shock loads when compared to physical treatment processes with the possible exception of rotating biological contactors. This and the high initial capital costs are serious drawbacks for using biological systems to treat intermittent combined sewer overflow unless they are designed as a dual treatment facility. Therefore, biological treatment of combined sewer overflow is generally viable only in integrated wet/dry-weather treatment facilities.

Disinfection. The major objective of disinfection is to control pathogens and other microorganisms in receiving waters. The disinfection agents commonly used in combined sewer overflow treatment are chlorine, calcium or sodium hypochlorite, chlorine dioxide, and ozone. They are all oxidizing agents, are corrosive to equipment, and are highly toxic to both microorganisms and people. Physical methods and other chemical agents have not had wide usage because of excessive costs or operational problems. The choice of a disinfecting agent will depend upon the unique characteristics of each agent, such as stability, chemical reactions with phenols and ammonia, disinfecting residual, and health hazards. Adequate mixing must be provided to force disinfectant contact with the maximum number of microorganisms. Mixing can be accomplished by mechanical flash mixers at the point of disinfectant addition and at intermittent points, by specially designed contact chambers, or both.

Sludge Disposal. As with all treatment processes, the concentrated waste residue generated by combined sewer overflow treatment must be disposed of properly.

It is estimated that treatment of CSO will generate 41.5 billion gallons of sludge per year, which is approximately 2.6 times the volume of raw primary wastewater treatment plant sludge. However, the average solids concentration in CSO sludge is about 1% compared to 2% to 7% in raw primary sludge. This is due to the high volume, low solids residuals generated by treatment processes employing screens. CSO residuals have a high grit and low volatile solids content when compared to raw primary sludge.

Preliminary economic evaluations indicate that lime stabilization, storage, gravity thickening, and land application is the most cost-effective disposal system. Application of combined sewage sludges on land must meet required maximum application rates for toxic metals, such as lead, zinc, copper, nickel, and cadmium, as do sludges from separate sanitary systems. Costs for overall CSO sludge handling depend on the type of CSO treatment process, and volume and characteristics of the sludge and the size of the CSO area, among other considerations.

COST EFFECTIVENESS

The first objective of any combined sewer overflow control project should be to obtain an understanding of how the existing collection and treatment system is operating. A cost-effective solution to a given CSO problem is not possible unless the number of overflow points, malfunctioning regulators, and separate sewer connections to combined sewers are identified. In many cases, the dry-weather WWTP is an integral part of the CSO control alternative, e.g., sewer flushing, swirl concentrators, and storage, and must therefore be included in the analysis.

The cost to remove BOD_5 for several CSO control alternatives is presented in Figure 7-1. Available capital cost data were updated to January 1978 dollars. Annual costs were developed based on an interest rate of 6-5/8% and an appropriate economic life of the facility. Sludge pumping and input or output pumping to a device are also included in the estimated operation and maintenance costs.

A population density of 16.73 persons per acre and an annual rainfall of 33.4 inches, which are national averages, were assumed for the unit cost calculations. These assumptions yield an approximate BOD_5 discharge of 136.2 pounds per acre per year. Storage treatment calculations were

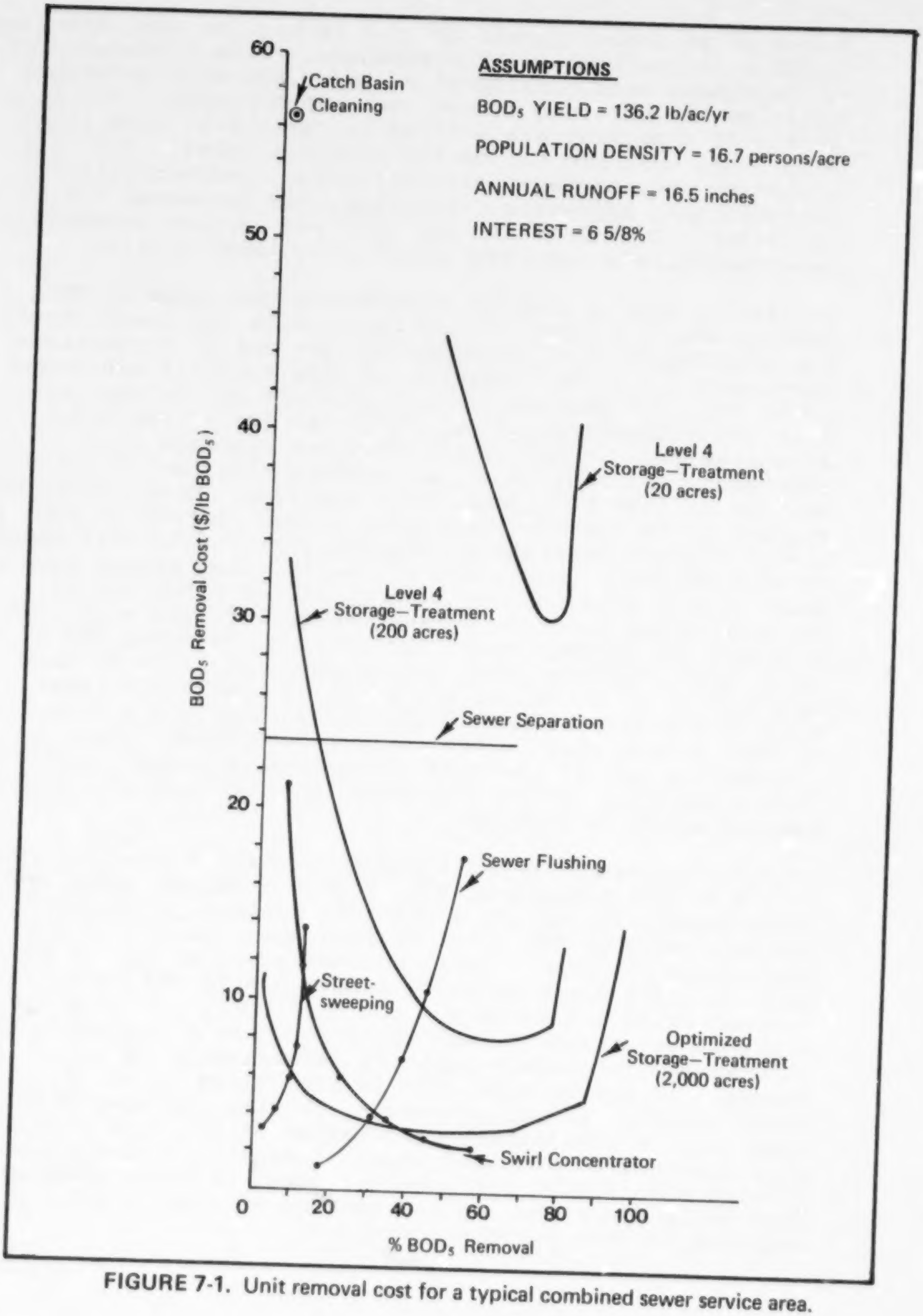


FIGURE 7-1. Unit removal cost for a typical combined sewer service area.

based on an annual runoff of 16.5 inches for 20-, 200-, and 2,000-acre combined sewer watersheds. Five different levels of treatment were considered on the 2,000-acre watershed to optimize the selected storage treatment system. The five levels of treatment are defined in Table 7-1, each level adds a new unit process to the previous level. The unit processes are, storage, microscreening, sedimentation-flocculation, high-rate filtration, and dissolved air flotation. Treatment for the 200- and 20-acre combined sewer watersheds was calculated using level 4 only.

Figure 7-1 can be used to approximate the range of BOD_5 removal where a given control process is the least costly or the most feasible alternative for the set of assumptions previously outlined. Results of this analysis are shown in Table 7-1. In general, source controls may be the most feasible alternative to remove 10% to 30% of the BOD_5 discharge from a small combined sewer drainage area. Catchbasin cleaning is not a feasible alternative since a maximum of 0.5% BOD_5 removal is possible. Sewer flushing appears to be the most promising source control of BOD_5 in a combined sewer watershed; however, the results will depend on site-specific conditions of the existing system such as sewer slope, overflow regulators, and WWTP facilities. Streetsweeping can provide some control at low unit cost. However, the maximum obtainable control is about 11% of the total watershed BOD load. Streetsweeping would be more competitive as a control technique on a separate sewer watershed since all pollutants accumulate on the watershed surface rather than in the collection system. Thus, a greater portion of the total watershed pollutant load would be available to the streetsweeper and the overall percent removal would be greater.

Collection system controls appear to have a feasible range of 30% to 60% removal of BOD_5 from a combined sewer system. Sewer separation may be a feasible control alternative for a drainage area of 200 acres or less when 50% to 60% BOD_5 removal is required. Swirl concentrators appear to be the most feasible alternative to remove 32% to 56% at a cost between $2.30 and $4.00 per pound of BOD_5. In-line storage with remote monitoring and control can be a cost-effective alternative if storage capacity is available in the existing system. An approximate cost is from $1.25 to $4.00 per pound of BOD_5, actually however, results are very site specific. A preliminary calculation of the cost to disconnect roof drains from combined sewers indicates a removal cost greater than $50.00 per pound of BOD_5. A major problem with roof drain disconnection and rooftop storage is obtaining cooperation from building owners.

Table 7-1
Range of Feasibility and Unit Costs
for CSO Technological Alternatives

	Range of Feasibility (% Removal)	Range of Costs ($/lb BOD_5)	Maximum BOD_5 Removal (%)
Source Controls			
Streetsweeping	2-11	3.00-7.50	12
Catch basin cleaning	0	>50.00	0.5
Sewer flushing	18-32	0.94-4.00	54
Collection System Controls			
Sewer separation	54-65	24.00	65
Swirl concentrators	32-56	2.30-4.00	56
Remote control in-line storage	Site specific	1.25-4.00	Site specific
Roof drain disconnection	Site specific	>50.00	Site specific
Storage/Treatment Systems			
2,000-acre level 1	10-16	4.70-6.00	25
Level 2	16-35	3.40-4.70	50
Level 3	35-61	3.10-3.40	79
Level 4	61-87	3.10-4.20	90
Level 5	87-95	4.20-14.00	95

Table 7-1--Continued

	Range of Feasibility (% Removal)	Range of Costs ($/lb BOD$_5$)	Maximum BOD$_5$ Removal (%)
200-acre Level 3	56-90	8.00-13.00	90
20-acre Level 3	65-90	30.00-41.00	90
Advanced Wastewater Treatment (AWT) (ADF = 5 to 25 mgd)			
Effluent BOD = 15 to 25 mg/l	--	1.90-2.60	--
Effluent BOD = 10 mg/l	--	2.80-4.00	--
Effluent BOD = 5 mg/l	--	4.90-7.00	--

Note: Assumptions common to all calculations:
Population density = 16.73/acre
BOD$_5$ yield = 136.23 lb/acre-year
Annual runoff = 16.5 inches
January 1978 dollars ENR = 2,672
Interest rate = 6-5/8%
Sludge pumping costs are included.

Storage/Treatment systems are based on runoff from a 2,000-acre drainage basin unless otherwise stated. Treatment levels are defined as follows.

Level 1 = Storage
Level 2 = Storage and microscreening
Level 3 = Storage, microscreening, and sedimentation-flocculation
Level 4 = Storage, microscreening, sedimentation-flocculation, and high-rate filtration
Level 5 = Storage, microscreening, dissolved air flotation, sedimentation-flocculation, and high-rate filtration

Advanced wastewater treatment costs are incremented costs incurred above secondary treatment. Secondary treatment will remove approximately 85% of the BOD$_5$ from the dry-weather flow at a cost of from $0.50 to $0.70 per pound of BOD$_5$ removed. The unit costs reported are those required to remove the remaining BOD$_5$ from the dry-weather flow.

Treatment facilities for the storage and control of CSO appear to be the most feasible control alternative for drainage areas greater than 2,000 acres when removals greater than 50% are required. A unit removal cost of \$3.00 to \$4.00 per pound of BOD_5 is maintained for 25% to 80% removal.

The cost of advanced wastewater treatment (AWT) for additional treatment of dry-weather flow is also given in Table 7-1. The AWT costs reported are incremental costs incurred above secondary treatment. Secondary treatment will remove approximately 85% of the dry-weather BOD_5 load at a cost of from \$0.50 to \$0.70 per pound of BOD_5 removed. The unit costs of AWT given in Table 7-1 represent the cost of removing the remaining BOD_5 from the dry-weather flow.

Often the pollution abatement choice in a combined sewer watershed with existing secondary treatment facilities is between additional treatment of the dry-weather flow (i.e., AWT) or treatment of the combined sewer overflow. The data reported in Table 7-1 indicate that the proper choice is not clear cut. The unit removal costs for AWT overlap the unit removal costs for CSO control. Therefore, the choice must be made based on individual analysis. It is clear, however, that available CSO controls are economically competitive with available AWT techniques.

It should be noted that this comparison is based on BOD_5 removal costs. Often, AWT is required for control of nutrients and not BOD. Since the major source of nutrients in a combined sewer watershed is the secondary WWTP effluent (see Chapter 6). AWT would have a clear economic advantage over CSO control if removal of nutrients is the objective.

The results presented in Figure 7-1 and Table 7-1 are for a typical combined sewer area and will not indicate the solution to site-specific problems. However, the results strongly indicate that large-scale integrated wastewater treatment facilities will be required to control combined sewer overflow pollution. The final combined sewer overflow control solution will usually be a combination of the available alternatives and must be tailored to the receiving water needs and uses. In Appendix C, references are cited which contain detailed information on the technical alternatives described in this section.

ENERGY USE

The energy use of several CSO control alternatives is presented in Table 7-2. Energy use is tabulated in units of kilowatt hours (kWh) per million gallons (MG) treated. Data in this table are taken from EPA report number EPA-430/9-77-011 entitled "Energy Conservation in Municipal Wastewater Treatment" (March 1977).

Table 7-2
Energy Use for Several CSO Control Alternatives

Treatment Process	Operating Parameters	Range of Energy Use[a] (kWh/MG)
Horizontal rotary screens	Loading = 35 gpm/ft^2	10-16
Vertical rotary screens	Loading = 80 gpm/ft^2	20
Vertical rotary screens heating backwash water	Backwash = 10 gpm @ 80 psi 160° F	30
Dissolved air flotation	Loading = 3,500 gpd/ft^2 Pressurized flow = 15%	750
High-rate filtration	Loading = 15 gpm/ft^2 Backwash = 20 gpm/ft^2	7.5-15
Storage reservoirs	Detention time = 12 hours Spray = $\frac{\text{3 gpm}}{\text{10 min ft}^2\text{ reservoir walls}}$	0.4-1.9
Sedimentation basins	Loading = 1,000 gpd/ft^2	0.8-1.0
Sludge pumping	Pumps run 10 min/hr Sludge removal = 65%	5
Rapid mixing	G = 300/sec, Temperature = 15° C Detention time = 1 min	10
Chlorine evaporation and feed	Dosage = 10 mg/1	3.5

Table 7-2--Continued

Treatment Process	Operating Parameters	Range of Energy Use[a] (kWh/MG)
Chlorine dioxide generation and feed	Dosage = 1.2 mg/l	1.4-9.5
Hypochlorite generation	Dosage = 10 mg/l	200

Source: "Energy Conservation in Municipal Wastewater Treatment." EPA-430/9-77-011. March 1977.

[a] For 10-mgd to 200-mgd treatment facilities.

Energy use was calculated for a range of treatment capacities from 10 mgd to 200 mgd. Dissolved air flotation has the highest energy consumption (750 kWh/MG) due to the large pumps required for operation. High-rate filtration (7.5 kWh/MG to 15 kWh/MG) and screens (10 kWh/MG to 20 kWh/MG) have high energy uses relative to sedimentation basins (0.08 kWh/MG to 1.0 kWh/MG). No data are available at this time for high gradient magnetic separation.

Disinfection with hypochlorite requires much more energy than chlorine or chlorine dioxide (200 kWh/MG versus 3.5 kWh/MG and 1.4-9.5 kWh/MG).

COMPARISON OF 25-mgd CSO TREATMENT FACILITIES

Seven different combined sewer overflow treatment systems, each with a design capacity of 25 mgd, are presented in Table 7-3. Data for capital costs, operating costs, land area required, and SS and BOD_5 removed are compared. Costs exclude diversion structures, pumping stations, bar screens, or sludge handling but include chlorination for disinfection. Operating costs assume that CSO treatment operation is for 30 overflow events per year. Capital costs are based on an Engineering News Record (ENR) construction cost index of 2672.

The swirl concentrator has a clear advantage in most columns, the lowest unit removal costs per percent SS and BOD_5 removed ($600 and $750, respectively) zero energy, and least land. The microstrainer is next with a unit removal cost of $2,090 for SS and $3,660 for BOD_5. The highest unit removal costs of SS and BOD_5 are for dissolved air flotation at $4,450 per percent SS removed and $6,230 per percent BOD_5 removed.

Table 7-3
Comparison of Seven 25-mgd CSO Treatment Systems

Treatment System	Average % Removal SS	Average % Removal BOD_5	Capital Costs	Operating Costs ($/yr)	Land Area Required (acres)	SS Unit Removal Cost ($/% SS removed)	BOD_5 Unit Removal Cost ($/% BOD_5 removed)
High-rate filtration with discostrainers	76	45	$2,589,000	$41,600	0.081	$3,650.00	$6,170.00
Flocculation-sedimentation with grit chamber	75	60	2,600,000	74,200	0.964	4,160.00	5,210.00
Microstrainers (horizontal shaft screens)	70	40	1,250,000	31,800	0.057	2,090.00	3,660.00
Dissolved air flotation with drum screens	70	50	2,690,000	64,700	0.528	4,450.00	6,230.00
Swirl concentrator with degritter	50	40	143,000	16,800	0.028	600.00	750.00
Vertical shaft rotary drum screens	40	35	1,060,000	24,400	0.052	3,040.00	3,470.00
High gradient magnetic separation	95	92	2,850,000	73,600	0.275	3,530.00	3,650.00

Note: Costs and energy usage exclude diversion structures, pumping stations, bar screens, or sludge handling but include chlorination for disinfection. Operating costs assume CSO treatment operating for 30 CSO events per year. Engineering News Record Construction Cost Index = 2672. (January 1978)

Chapter 8
DISCUSSION OF LEGISLATIVE ALTERNATIVES

The five legislative alternatives for funding combined sewer overflow pollution abatement projects, outlined in Chapter 2, are discussed in this chapter. This discussion is based on the information presented in the report and on comments received from states, municipalities, planning agencies, and EPA staff.

The alternatives are expanded somewhat from the outline form of Chapter 2, and the advantages and disadvantages of each are listed. Advantages and disadvantages are a subjective topic since what may be an advantage to one group or interest could well be a disadvantage to another. Advantages and disadvantages presented herein are developed from the viewpoint of maximizing the water quality benefits obtained from investment of water pollution control dollars while maintaining a controllable funding program which will solve the CSO pollution problem in a timely fashion. This controllable funding program should also be flexible enough to interface with solutions to other urban water resources problems so that overall, the least costly solutions can be obtained.

ALTERNATIVE 1--CONTINUE WITH PRESENT LAW

"Combined sewer overflow pollution abatement projects would be funded under the existing provisions of PL 92-500 as amended in December 1977, by the Clean Water Act of 1977. Combined sewer overflow control projects would be funded under section 201 of the law."

The procedure for project implementation would be the same as it exists today and would consist of three major steps: (1) facilities planning, (2) preparation of construction documents (design), and (3) construction. The decisions relating to the extent of federal participation in individual CSO pollution abatement projects would be based on least cost pollution control alternatives as well as on the project's position on the State priority lists.

This alternative is flexible enough to allow some adjustment in the present program if these adjustments can be achieved by administrative rather than legislative action. For example, existing EPA guidelines, such as PG-61 and PRM No. 77-4, may be subject to change if deemed appropriate in the future.

Advantages of Alternative 1

The major advantage of the present program is that it is a working program and that individuals involved in water pollution control, including state agencies, municipalities, and private design firms, are familiar with the program.

Another advantage of the present program is that it places CSO pollution abatement projects in perspective with other pollution control projects. Competition under the state priority system allows for the comparison of pollution reductions achieved by CSO projects with pollution reductions achieved by other projects. Theoretically, this process should result in placement of the project at the proper location on the state priority list regardless of the source of the pollutant. Therefore, the present system allows for considerable input by the states regarding where and how their share of the federal water pollution control grants should be invested.

The ultimate objective of the current water pollution control program is to remove pollutants from the receiving water. Secondary treatment of municipal wastewater, advanced waste treatment (AWT) of municipal wastewater, and combined sewer overflow control are all tools which may be used to meet this ultimate objective. Secondary wastewater treatment is obviously the most cost-effective method by which pollutants can be removed. However, once secondary treatment is achieved, there is no clear economic advantage for AWT versus CSO control or vice versa (See Chapter 7). The most economical method for removing pollutants once secondary standards are achieved will depend upon which pollutants are of interest, the degree of additional removal required, and the physical and hydrologic characteristics of the combined sewer watershed. Under the current grants program, such tradeoffs in any given municipality may be compared during the planning process, which is a major advantage of the present program. This competition between types of controls (i.e., AWT versus CSO control) could be largely bypassed if a separate grants program for CSO control were established.

Continuation of the present system for funding CSO pollution control projects would also avoid the delays which would be encountered if the present program is modified by legislative action.

Disadvantages of Alternative 1

The present facilities planning process has not been applied to combined sewer overflow abatement on a large scale except for a few major projects. Past emphasis has been placed on control of point source discharges, and only a small portion of existing CSO control needs have been addressed in current plans. Thus, there exists today some uncertainty on how best to apply the present construction grants program to CSO abatement projects. However, this uncertainty could probably be reduced to a great extent by development of additional administrative guidelines rather by legislative action. Also, funding of CSO control projects is not generally delayed by the current construction grants process but by low ranking on the state priority list. The current program, including the state priority list system, results in uncertainly in the time required to correct CSO pollution as discussed in Chapter 5. The rate at which states fund CSO projects will have a significant effect on overall CSO correction time. This rate is indeterminate under the present program.

A further disadvantage of the program as it exists under present law is its single purpose nature. The objective of the current water pollution abatement program is to identify municipal pollution control needs and to provide federal assistance for the construction of necessary facilities. The single purpose of pollution abatement does not easily lend itself to the examination of other urban water resources benefits derived from construction of CSO pollution abatement facilities, such as improved urban drainage and flood control.

The current law is designed to assist municipalities in construction of needed water pollution control facilities. Operation and maintenance costs are the responsibility of the municipal owner. Therefore, proposed solutions may tend to be skewed toward construction of treatment facilities (capital improvements) since these are grant eligible rather than toward implementation of management practices which are not currently grant eligible. Thus, proposed solutions to the CSO program developed under the present law may be suboptimal from the standpoint of total urban water resources management and may also be suboptimal for the single purpose of pollution abatement because only selected portions of pollution control needs (i.e., capital expenditures) are grant eligible.

The overall cost savings which would result from funding management practices may be more theoretical than actual. The discussion of the unit cost of technological alternatives for CSO control presented in Chapter 7 indicates that there is no clear-cut cost advantage for known management practices for CSO control. Streetsweeping and catch basin cleaning have limited effectiveness at relatively high cost. Sewer flushing can be quite competitive with other techniques, from both a unit cost and effectiveness standpoint. However, automatic sewer flushing systems can be designed which minimize operation and maintenance costs and maximize the grant-eligible portion, which could make such systems attractive to municipalities under the current eligibility practices.

ALTERNATIVE 2--MODIFICATION OF CURRENT LAW TO PROVIDE CONGRESSIONAL FUNDING OF LARGER PROJECTS

"Major combined sewer overflow pollution abatement projects would be subject to funding on a case-by-case basis. Once the planning process is complete, each project would be presented to Congress. Congress would have a clear picture of the costs likely to be incurred and the benefits likely to accrue from the plan. The decision whether to fund all of the project, a portion of the project, or none of the project would rest with Congress."

Under this alternative, the basic framework of the existing law is assumed to be adequate or nearly so. National CSO pollution control construction needs are estimated to be nearly $20 billion in January 1978 dollars. Based on 75% grant eligibility, this would result in an expenditure of nearly $15 billion in federal tax funds. Perhaps funding decisions of this magnitude should be the responsibility of the legislative rather than the executive branch of government. Therefore, the purpose of Alternative 2 would be to transfer the final decision to fund a given major project from the executive branch of government to the legislative branch of government.

Theoretically, the above decision process could be applied to all urban areas presently served by combined sewer systems. However, the number of such communities is so large, approximately 1,300, that this alternative may be unmanageable on a nationwide basis. Thus, a definition of "major combined sewer overflow pollution abatement project" is required. A possible definition could be similar to the criteria used to develop the list of urban areas faced with major CSO control problems which is presented in Table 5-1. This table lists 58 urban areas located in SMSA's with combined sewer service areas equal to or greater than 10,000 acres in size. This listing accounts for approximately 83% of the total national combined sewer service areas and for 81% of the total national population served by combined sewers. These cities are likely to account for at least 80% of the total national needs for CSO control. Obviously, a large portion of the total problem is concentrated in relatively few geographic locations which may be termed major project areas.

Under Alternative 2, those projects which do not meet the criteria for major projects would be funded through the existing grants program.

Advantages of Alternative 2

The advantage of Alternative 2 "Modification of Current Law to Provide Congressional Funding of Larger Projects" is that responsibility for funding a given major CSO pollution control project is transferred from the executive branch of government to the legislative branch of government. In this manner, the costs and benefits of a given pollution control project can be weighed against the costs and benefits of other national needs which are known to the legislators. The decision to spend limited federal funds for pollution control or, for example, highway safety or education would rest with elected officials.

Disadvantages of Alternative 2

There are several disadvantages of Alternative 2. First, it would take some time to develop and pass such a law, which would result in an equal period of construction delays. Second, once a planning procedure was established and a given plan and funding request was submitted to Congress for action, an additional unknown period of time would elapse before a decision is reached. During this entire period, the municipality would be uncertain as to timing and level of funding of their project. Overall CSO correction time would be even less certain under Alternative 2 than it is under the present program.

Another major disadvantage for Alternative 2 is that it would effectively remove local and state authorities from the decision-making process, which could result in an overall adverse effect to a given state's water pollution control program.

ALTERNATIVE 3--MODIFICATION OF CURRENT LAW TO PROVIDE FUNDING FOR NONSTRUCTURAL CONTROL TECHNIQUES

"Combined sewer overflow pollution abatement projects may include a mixture of both structural controls and management practices. Management practices consist of those techniques which require very few, if any, capital expenditures. Such operation and maintenance costs are not grant eligible under the current law."

Pollution from combined sewer overflow may be reduced by several different techniques, as discussed in Chapter 7. These techniques may be structural such as expansion of existing treatment plants to treat a larger portion of the flow, construction of storage basins to capture excess flow for subsequent treatment, or physical separation of the sewers. Each of the above may, under certain conditions, be grant eligible. On the other hand, techniques exist which require very few, if any, capital expenditures. These are termed management practices. In certain situations, it may be more cost effective (i.e., less total cost per unit of pollutant removed) to implement a nonstructural control than to construct a structural control. However, federal aid is available only in the form of construction grants, which may tend to discourage the use of cost-effective nonstructural alternatives. Modification of the existing law to allow federal funding of management practices where they are shown to be cost effective would be a step in the direction of providing optimal pollution control strategies. However, as discussed under Alternative 1, the potential cost savings associated with implementation of management practices for CSO control may be more theoretical than actual.

Advantages of Alternative 3

The major advantage of Alternative 3 is that it has the potential for minimizing the overall unit cost of pollution removal for CSO control projects.

Disadvantages of Alternative 3

Implementation of Alternative 3 would constitute a major shift in federal involvement in water pollution control. To date, federal involvement has been limited to construction grants designed to aid municipalities with capital expenditures. The responsibility for operating and maintaining the completed facilities lies entirely with the owner. If any operation and maintenance costs become grant eligible, the precedent could be logically expanded to all operation and maintenance costs including treatment plant operation, sewer cleaning, streetsweeping, inflow correction, or any other activity which results in removal of any pollutants from a combined sewer watershed or separate sanitary collection network. Thus, federal participation could expand into many areas on a long-term basis, which are now clearly beyond the scope of federal participation.

For example, if the operation and maintenance (O&M) portion of streetsweeping and/or combined sewer flushing (which are relatively ineffective pollution control practices compared to secondary wastewater treatment) became grant-eligible, a strong argument could be made for treatment plant O&M eligibility. Operation and maintenance of a secondary wastewater treatment plant accounts for approximately 20% to 30% of the total annual cost. Thus, if O&M grants as well as construction grants were awarded for wastewater treatment, federal participation could easily be expanded by 25% to 45% above current levels due to WWTP O&M alone. Ultimately, the addition of O&M cost in municipal grants could add several billion dollars per year to the federal share.

In addition, as previously discussed in Chapter 7 and under Alternative 1, the most competitive of the available combined sewer management practices appears to be sewer flushing. Sewer flushing systems can be designed to minimize O&M costs and to maximize the capital or grant-eligible portion (by use of automatic flushing stations in lieu of manual flushing) which should make such systems attractive under current eligibility practices.

Other disadvantages include delays related to the development and passage of enabling legislation and in a reevaluation of plans previously approved.

ALTERNATIVE 4--MODIFICATION OF CURRENT LAW TO PROVIDE A SEPARATE FUNDING FOR COMBINED SEWER OVERFLOW PROJECTS

"Combined sewer overflow pollution abatement projects would be funded from amounts specifically earmarked by Congress for this purpose. The funds could be made available either from a national fund or as a set-aside within each State's allotment of grant funds."

This approach would provide a certain annual allocation of funds for the purpose of abatement of pollution from combined sewer overflow. The set-aside percentage could be the ratio of state CSO needs to total state allocation, or it could be a national fund established as the ratio of national CSO control needs to total national needs. If this approach were utilized, then the problem will become one of determining the optimum use of the available funds.

The planning process could be multipurpose, with funds available for the water quality improvement portion of the project. This alternative could be applied nationwide to all urban areas served by combined sewers, or it could be integrated with Alternative 2 to provide a planning and funding vehicle for both major and minor projects.

Alternative 4, along with Alternative 1, received the most favorable comments from states and municipalities submitting replies, as reported in Appendix A. Most favorable responses recommended a national allotment rather than an additional state-by-state set-aside. Such an approach would in effect establish a separate grants program for CSO control. Since CSO control problems are substantially different from dry-weather flow pollution control problems which require different types of analysis, this alternative has intuitive merit. However, fragmentation of the grants program could result in suboptimum solutions to an individual municipalities pollution abatement problem.

Advantages of Alternative 4

The major advantage of this approach is that nationwide CSO pollution correction effort would be known and that municipalities could plan on a long-term and orderly basis, since there would be some assurance that construction funds would be available during the year that construction is planned. That is, an assured level of CSO control funding projected over a realistic and predictable timetable would be provided. This alternative would also reduce the uncertainities associated with CSO correction time.

Disadvantages of Alternative 4

Because funding would be earmarked for a special category of pollution control projects, these funds would be utilized for that purpose regardless of the relative effectiveness in reducing pollution. That is, the competition between types of projects provided by the present program through the state priority procedure would be largely bypassed under Alternative 4.

Delays would also be encountered due to the time required to develop and pass the enabling legislation. However, these delays should not be as great as for Alternatives 2 and 3 since only the method of funding and not the basic decision process or overall grant eligibility is in question.

ALTERNATIVE 5--DEVELOPMENT OF A NEW LAW TO PROVIDE FUNDING FOR MULTIPURPOSE URBAN WATER RESOURCES PROJECTS

"The new legislation would provide for multipurpose urban water resources projects planning and construction funding. The objectives may include: (1) recreation, (2) urban drainage, (3) point source pollution control, (4) control of pollution from combined sewer overflows, (5) control of pollution from urban stormwater runoff, (6) urban water supply including water reuse, and (7) major flood control projects. Funds for those portions of each project which provide substantial benefits relative to costs could be authorized by Congress on a case-by-case basis, or drawn from existing programs such as those administered by EPA, HUD, and EDA."

A new law for multipurpose urban water resources planning and construction offers the greatest potential for achieving optimum investment of funds to achieve nationwide urban water quality goals. It also offers perhaps the greatest potential for diversion of funds to other objectives due to the realities associated with growing water resources and other national needs. While these may represent extremes, it is probable that passage of new multipurpose legislation is a higher risk approach to the achievement of urban water quality objectives than is the continuation or modification of the present program.

National CSO pollution control needs could run into the tens of billions of dollars. Single projects for large metropolitan areas will cost hundreds of millions of dollars. Under the present law, decisions regarding the federal portion of these expenditures are the responsibility of the EPA Administrator and, thus, the responsibility of the executive branch of government.

If total multipurpose urban water resources needs are considered including water supply and urban drainage, then total expenditures for a single city could easily reach several billions of dollars (See Chapter 1). When faced with such a huge expenditure, the decision as to who pays what portion of the cost becomes very important. Perhaps decisions of this magnitude should be made by the legislative branch of the government. Before such a decision can be adequately addressed, the costs and benefits associated with (or allocated to) each of the multipurpose objectives must be known. Under Alternative 5, CSO control, along with other major urban water resources needs, could be weighed against national needs such as education and defense and could be compared to our available limited resources.

Advantages of Alternative 5

Implementation of Alternative 5 would provide a needed remedy for the present fragmentation of urban water resources efforts which currently involve several federal agencies, each with a limited role, the states, and the municipalities. Elimination or reduction of this present fragmentation is considered a major advantage of Alternative 5.

Another advantage of Alternative 5 is that funding for CSO and other urban pollution control projects would be evaluated against all other urban water resources projects; therefore, the optimum investment of available funds would be known and could be achieved if this flexibility were built into the enabling legislation.

Congress would have a clear picture of the costs and benefits not only of the water quality control portion of an urban area's water resources needs, but also of all other water resources needs of which water quality control may be only a small part. Thus, an overview would be available before the key decisions for a given project were made.

quality objectives than is the continuation or modification of the present program.

National CSO pollution control needs could run into the tens of billions of dollars. Single projects for large metropolitan areas will cost hundreds of millions of dollars. Under the present law, decisions regarding the federal portion of these expenditures are the responsibility of the EPA Administrator and, thus, the responsibility of the executive branch of government.

If total multipurpose urban water resources needs are considered including water supply and urban drainage, then total expenditures for a single city could easily reach several billions of dollars (See Chapter 1). When faced with such a huge expenditure, the decision as to who pays what portion of the cost becomes very important. Perhaps decisions of this magnitude should be made by the legislative branch of the government. Before such a decision can be adequately addressed, the costs and benefits associated with (or allocated to) each of the multipurpose objectives must be known. Under Alternative 5, CSO control, along with other major urban water resources needs, could be weighed against national needs such as education and defense and could be compared to our available limited resources.

Advantages of Alternative 5

Implementation of Alternative 5 would provide a needed remedy for the present fragmentation of urban water resources efforts which currently involve several federal agencies, each with a limited role, the states, and the municipalities. Elimination or reduction of this present fragmentation is considered a major advantage of Alternative 5.

Another advantage of Alternative 5 is that funding for CSO and other urban pollution control projects would be evaluated against all other urban water resources projects; therefore, the optimum investment of available funds would be known and could be achieved if this flexibility were built into the enabling legislation.

Congress would have a clear picture of the costs and benefits not only of the water quality control portion of an urban area's water resources needs, but also of all other water resources needs of which water quality control may be only a small part. Thus, an overview would be available before the key decisions for a given project were made.

Disadvantages of Alternative 5

Implementation of Alternative 5 would result in delays in construction of CSO pollution control facilities much greater than those delays likely to be encountered in any of the other alternatives. These delays would be due to the fact that Alternative 5 represents the most radical departure from present practice and would require the cooperation and coordination of several federal agencies as well as state and local governments. Many comments received from state and local officials questioned the practical workability of such an approach.

A very flexible interpretation of Alternative 5 would represent a significant departure from the philosophy of PL 92-500, which is to control water pollution and to set aside funds to be used for this single purpose. It is not the intent of the present law to allow free competition among multipurpose objectives for thse funds. Details of this question would have to be addressed in the language of the enabling legislation. Safeguards could be built in to protect or modify the intent of PL 92-500 as deemed appropriate.

Alternative 5 does not address the question of CSO pollution control outside of major urban areas. These combined sewer systems would have to be handled under a separate program.

SUMMARY OF ALTERNATIVES

Alternative 1 "Continue with Present Law" appears to be one of the most viable and would probably result in minimum construction delays. Total time to correction would remain an unknown since all projects would be subject to the states' priority system.

Alternative 2 "Modification of Current Law to Provide Congressional Funding of Larger Projects" received little support from local and state officials submitting comments. This alternative is preceived as adding substantial delays and uncertainty to the CSO pollution abatement process without adding any quality to the end product.

Alternative 3 "Modification of Current Law to Provide Funding for Nonstructural Control Techniques" does not at this time appear viable because of its limited probable benefits and the high risk of expanding the federal role in water quality control far beyond current limits.

Alternative 4 "Modification of Current Law to Provide a Separate Funding for Combined Sewer Overflow Projects" also appears to be one of the most viable and workable solutions to the problem of funding CSO pollution abatement projects. In general, individuals located in areas of the country with major combined sewer service areas who submitted comments on the alternatives favored Alternative 4 with a national fund (separate grants program) while individuals located in areas of the country with few combined sewer systems who submitted comments favored Alternative 1.

Alternative 5 "Development of a New Law to Provide Funding for Multipurpose Urban Water Resources Projects" raises questions of national urban water resources policy far beyond the question of CSO pollution control. Most individuals who submitted comments questioned the workability of such an approach, based in part upon anticipated substantial construction delays.

RECOMMENDATIONS

It is recommended that Alternative 1, "Continue with Present Law", be adopted as the funding method for future combined sewer overflow pollution abatement projects. However, if CSO pollution is to be corrected in a reasonable period of time, states with substantial CSO needs must be willing to spend a greater share of their annual allocation on CSO projects. Moreover, the relative size of the allocation to these states would be increased if annual appropriations were alloted among the states based to a greater degree on CSO needs.

It must be remembered that any increase in spending for combined sewer overflow control needs (Category V) will result in a decrease in spending for all other pollution control needs (Categories I-IVB). These tradeoffs must be weighted carefully for any given municipality. It is believed that this site-specific examination of pollution control tradeoffs can best be accomplished in a timely fashion under the present law.

This report is based on the best available information, including unpublished data currently being gathered for the 1978 Needs Survey. The Needs Survey results, due 10 February 1979, will permit refinement of the conclusions and recommendations in this report. The Needs Survey results will, for example, provide a revised estimate by state of the cost of controlling combined sewer overflow and an analysis of the impact of pollutant loads for combined sewers on receiving waters.

APPENDIX A
CORRESPONDENCE

ARIZONA DEPARTMENT OF HEALTH SERVICES

Division of Environmental Health Services

Bruce Babbitt, Governor
~~[illegible]~~
SUZANNE DANDOY,M.D.,M.P.H.,Director

July 21, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Cook:

This Department has reviewed your list of legislative alternatives for funding combined sewer abatement projects.

Although Arizona does not have a great amount of experience with combined sewers, Alternative 1 appears to be the best option; to continue to solve pollution problems from combined sewers in priority order with all other projects.

Sincerely,

Ronald L. Miller, Ph.D., Chief
Bureau of Water Quality Control

RLM:JWS:ca

State Health Building **1740 West Adams Street** **Phoenix, Arizona 85**

STATE OF CALIFORNIA—THE RESOURCES AGENCY
EDMUND G. BROWN JR., Governor

STATE WATER RESOURCES CONTROL BOARD
DIVISION OF WATER QUALITY
P. O. BOX 100 • SACRAMENTO 95801
(916) 445-7971

In Reply Refer
to: 500:RW

JUL 28 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

LEGISLATIVE ALTERNATIVES FOR COMBINED SEWER PROJECTS

We have reviewed your subject memo dated July 3, 1978.

California has very few combined sewer systems. In fact, San Francisco is the only city where work needed to deal with the existing problems involves extremely large capital expenditures. Step 3 grants have been made to Sacramento, the next largest city with combined sewers. The several remaining combined sewer systems are rather small.

With respect to your alternatives for combined sewers, we prefer No. 1 as it has been satisfactory for funding needed projects in California. Our concern is that a system not be developed which would introduce long delays in the San Francisco combined sewer project which is partly in construction, partly in design, and partly in planning.

Your other alternatives, although not particularly attractive as a way to complete San Francisco project, seem to be an adequate base for a response to the law.

Thank you for the opportunity to comment on this subject.

Ray Walsh

Ray Walsh
Assistant Division Chief

GOVERNMENT OF THE DISTRICT OF COLUMBIA
DEPARTMENT OF ENVIRONMENTAL SERVICES
ENVIRONMENTAL HEALTH ADMINISTRATION
WASHINGTON, D. C. 20002

July 24, 1978

Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 "M" Street, S. W.
Washington, D. C. 20460

Subject: (Legislative Alternatives for Combined Sewer Projects)

Dear Mr. Cook:

A review of the five legislative alternatives for funding combined sewer abatement projects indicates your outline is all inclusive and no additional legislative alternatives are suggested. Furthermore, this office profers alternative 3 - "Modification of current law to provide funding for nonstructural control techniques".

At this time , alternative 3 does not meet funding requirements under existing law. It is our suggestion that the law should be modified to include funding for best management practices because we believe this to be the most cost effective of the five legislative alternatives.

Sincerely,

ENVIRONMENTAL HEALTH ADMINISTRATION
BAILUS WALKER, Jr., Ph.D., M.P.H.
Environmental Health Scientist
Administrator

Robert Heckelman

Robert Heckelman, Chief
Water Hygiene Division
Bureau of Air and Water Quality

Department of Natural Resources
ENVIRONMENTAL PROTECTION DIVISION
270 WASHINGTON STREET, S.W.
ATLANTA, GEORGIA 30334

JOE D. TANNER
Commissioner

J. LEONARD LEDBETTER
Division Director

July 25, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S. W.
Washington, D. C. 20460

RE: Legislative Alternatives for
Combined Sewer Projects Proposal
Georgia EPD Review Comments

Dear Mr. Cook:

We appreciate the opportunity to comment on the proposed Combined Sewer Overflow (CSO) Treatment Alternatives. In general the Georgia Environmental Protection Division believes that the most appropriate and efficient manner of funding Georgia's CSO Projects is through the present planning, design and construction processes outlined in P.L. 92-500. CSO's are a major problem in Georgia and the EPD is working towards the funding and mitigation of these problems within the confines of the present grants system. Two City of Atlanta projects are nearing completion of design with relatively few problems to date. Both projects have been administered under the P.L. 92-500 grants program and are excellent examples of the present system's ability to handle CSO projects.

Our specific item by item review comments are listed below:

1. Alternative 1 - Continue with present law

   As stated above, funding CSO's treatment under the present grants system is considered the most workable situation presented by the referenced Legislative Outline.

2. Alternative 2 - Modification of current law to provide Congressional funding of larger projects

   This proposal is not consistent with P.L. 92-500. Consideration on a case-by-case basis by Congress would cause serious funding delays and would remove local and State authorities from the decision making process, which is unacceptable.

3. Alternative 3 - Modification of current law to provide funding for nonstructural control techniques

   This alternative is potentially acceptable but we reserve comment until further development of it is complete.

[illegible] EQUAL EMPLOYMENT OPPORTUNITY EMPLOYER

4. Alternative 4 - Modification of current law to provide a separate funding for combined sewer overflow projects

   This alternative would possibly cause revisions of the present grants program which is unacceptable. Also, serious delays in funding are assured, as they are under Alternative 2, if Congressional action is needed.

5. Alternative 5 - Development of a new law to provide funding for multipurpose urban water resources projects

   This proposed legislation would cause severe delays, misplaced priorities and administrative problems within the existing systems administered by EPA, HUD and EDA. There would be a bureaucratic maze for each project to negotiate in order for it to receive funding. Timely funding would be impossible. CSO projects should be evaluated with other pollution control projects in order for a fair priority to be established, but should not be evaluated against general water resources projects.

We hope these comments are helpful. If you have any questions, feel free to contact us.

Sincerely,

Harold F. Reheis, P.E., Chief
Water Quality Control Section

HFR:rb

iowa department of environmental quality
reply to: Darrell McAllister
phone: 515/281-8982

July 19, 1978

Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M. Street S.W.
Washington, D.C. 20460

RE: Alternatives for Combined Sewer Projects

Dear Mr. Cook:

EPA's memorandum of July 3, 1978 requesting comments on alternatives for combined sewer projects has been reviewed by this office and would offer the following suggestions.

The problem of combined sewer overflows exists both in large and small cities. Your memorandum appeared to focus on larger cities and did not provide an alternative that is trying to be implemented in Iowa. This agency has been trying to get Regional EPA approval for Step 1 construction grant funds to allow a limited study of the combined sewer problems. The limited study would provide cost estimates for several alternatives and the city would select an alternative, or the state water pollution control agency would indicate an alternative, to be implemented. It would be the responsibility of the city to implement the approved alternative without Step 2 or 3 construction grant funds. In some cases, the abatement program may be available for grant funds.

The Department feels this alternative would not require legislative action as four of the five alternatives presented in the memo did. Also, implementation of this alternative would allow EPA to gather needed information for making decisions on funding of combined sewer abatement projects.

This Department appreciates the opportunity to comment and is available to supply more information if you need it.

Sincerely,

CHEMICALS AND WATER QUALITY DIVISION

Darrell McAllister

Darrell McAllister, Chief
Construction Grants Section

DM:mla

Henry A. Wallace Building, Des Moines, Iowa 50319

State of Kansas . . . ROBERT F. BENNETT, *Governor*

DEPARTMENT OF HEALTH AND ENVIRONMENT

DWIGHT F. METZLER, *Secretary*
Topeka, Kansas 66620

July 18, 1978

Mr. Michael B. Cook
Chief, Facilities Requirement Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mike:

Mr. Rhett's memorandum of July 3, 1978 requests comments on "Legislative Alternatives for Combined Sewer Projects". Our comments on the five basic legislative alternatives are as follows:

1) There is considerable confusion as to the application of the present law and/or the definition of combined sewers. It seems to me imperative that these two items be addressed in the preamble to the study.

   It is easy to define the traditional combined sewer system in which a single set of pipes carries both sanitary and storm waste and permits overflows whenever the total load exceeds the capacity of the system. The situation is, however, radically different when the community has attached a substantial sanitary sewer load at the periphery of the combined sewer system. Under this configuration, the combined sewers then serve a dual purpose i.e., a combined sewer in the traditional sense, and an interceptor or transport sewer for separated sewage. Discharges which occur from such a hybrid system may result in massive bypassing of sanitary sewage. It is my opinion that hybrid systems of this nature should be treated largely as a sanitary sewer system.

   There seems to be considerable confusion as to the meaning of the present law. There are those who believe Congress passed a law which required that all discharges be permitted under the NPDES and that a minimum of secondary treatment be provided for all discharges by July 1, 1977. There are others who take the position that Congress did not intend either the permitting or minimum level of treatment portions of the Act to apply to bypasses or to overflows from traditional combined systems. It is also our impression that there has been considerable variation among Regional offices in approving funding for combined sewer projects. Under alternative one, it will be necessary to clearly establish present law both in terms of minimum level of treatment and NPDES responsibilities.

2) A problem may be associated with discharges into coastal waters. Public Law 95-217 modified minimum treatment level requirements for certain municipalities in coastal areas.

3) We believe that a sixth alternative should be included which would provide for full or partial exemption of tradition or hybrid combined systems from compliance with the minimum treatment and/or NPDES requirements of Public Law 92-500. We do not necessarily support such an alternative, but believe it should be considered. A sub-option could provide for funding under any of the described five options for those situations in which it could be established that combined sewer overflows would [redacted] result in significant damage to receiving waters.

Sincerely yours,

Eugene Jensen

Eugene T. Jensen, Director
Bureau of Water Quality

ETJ:lm

State of Maryland

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
ENVIRONMENTAL HEALTH ADMINISTRATION
P.O. BOX 13387
201 WEST PRESTON STREET
BALTIMORE, MARYLAND 21203
PHONE • 301-383-2740

NEIL SOLOMON, M.D., PH.D.
SECRETARY

DONALD H. NOREN
DIRECTOR

July 26, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
U. S. Environmental Protection Agency
401 M Street, S.W.
Washington, D. C. 20460

Dear Mr. Cook:

RE: Legislative Alternatives
for Combined Sewer Projects

This letter is in response to Mr. John T. Rhett's memorandum of July 3, 1978, in which he requested comments on legislative alternatives to be studied in the EPA report on combined sewer overflows required by Section 516(c) of the Clean Water Act.

We suggest that construction projects to alleviate combined sewer overflows be funded under the present law. Such projects should be subject to the State's approved Priority System and be ranked on the State's Priority List along with all other treatment works to be funded under the Act. This will assure that available funds are utilized on those projects which will be most effective in reducing water pollution regardless of the source of pollution.

"Management practices" alleviate or eliminate combined sewer overflows should be made grant eligible through an amendment to the present law, but funded through a separate appropriation. We believe Title II of the present Act should be used exclusively for construction related activities.

Note that our suggestions closely parallel your proposed Alternatives 1 and 3. Alternative 2 is not recommended because of the opportunity for it to become a "pork barrel" type program. Alternative 4 would direct funds to a specific class of projects regardless of their effectiveness in reducing pollution and for this reason is not recommended. Alternative 5 would require new, complex legislation and the extensive interagency coordination required to implement it could serve to make it ineffective.

We appreciate this opportunity to provide our comments on the alternatives you plan to analyze in your report.

Sincerely yours,

Donald H. Noren, Director
Environmental Health Administration

DHN:dvs

cc: Mr. John Potosnak
The Honorable Neil Solomon
Dr. Benjamin D. White

Minnesota Pollution Control Agency

(612) 296-7301

AUG 16 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
U. S. Environmental Protection Agency
401 M Street Southwest
Washington, D.C.   20460

Re: Legislative Alternatives for Combined Sewer Projects

Dear Mr. Cook:

We have reviewed the referenced memorandum of July 3, 1978 pertaining to the U. S. Environmental Protection Agency (EPA) report to Congress on funding combined sewer abatement projects, and we wish to make the following comments.

We believe the five selected alternatives, as proposed, are viable approaches, representative of the funding methodology which must be considered for further detailed evaluation. Specific comments are listed for the indicated alternatives and address mainly clarification in the scope of the individual alternatives.

Alternative 1 - Continue with the present law. It is unclear whether the Act will remain unchanged or whether the Regulations and Program Memorandums will remain unchanged as well. An evaluation should be made of how far EPA could proceed in changing the program without changing the Act; i.e., shifting of priorities and acceptable pollution abatement solutions.

Alternative 2 - Modification of current law to provide Congressional funding of larger projects. The scope of this alternative is unclear as to how smaller combined sewer overflow projects would be addressed in this alternative; i.e., would the funding be exclusive to larger projects?

Alternative 5 - Development of a new law to provide funding for multipurpose urban water resources projects. This alternative is broad in definition and should be given appropriate resource allocation in its development. Another approach to Alternative 5 would be to divide the alternative into two subparts: One

1935 West County Road B2, Roseville, Minnesota 55113
Regional Offices • Duluth / Brainerd / Fergus Falls / Marshall / Rochester / Roseville
Equal Opportunity Employer

alternative might be an evaluation of a comprehensive approach, and a second alternative could be the evaluation of handling the concept through existing programs; i.e., the 208 Program and other water management programs.

We hope that these comments will be considered in developing the report on funding legislation to Congress. Should any questions arise concerning these comments, my staff will be available to offer assistance.

Sincerely,

Sandra Gardebring

Sandra S. Gardebring
Executive Director

SSG:sl

North Carolina Department of Natural Resources & Community Development
James B. Hunt, Jr., Governor
Howard N. Lee, Secretary

Division of Environmental Management

July 20, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch(WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Cook:

In response to Mr. John T. Rhett's July 3 memorandum, the North Carolina Department of Natural Resources and Community Development, Division of Environmental Management is pleased to offer the following comments for your consideration relative to "Legislative Alternatives For Funding Combined Sewer Abatement Projects". Our comments are brief, and address one general and two specific areas of concern.

1. In all five(5) legislative alternatives, the prime consideration for funding any combined sewer abatement project should be based on the project's net economic benefits. Thus, any project not proven to be cost-effective would not be funded.

2. Legislative alternative #5 is too broad in its coverage. We suggest that the scope of this proposed legislation be limited to: point source pollution control, control of pollution from combined sewer overflows, control of pollution from urban storm water runoff, and urban water supply including reuse. This reduction in coverage will make the proposed legislation more implementable and thereby much more effective in its effort to reduce water pollution levels.

3. Finally, we believe evaluation of a sixth legislative alternative is in order: discontinue funding of combined sewer abatement projects and transfer these funds to construction grants and non-point source pollution abatement projects. Nationally, this transfer of funds should result in greater reduction of surface water pollution and contribute significantly to the goal of pollution-free waters.

P. O. Box 27687 Raleigh, North Carolina 27611

An Equal Opportunity Affirmative Action Employer

We appreciate this opportunity to offer our comments and we trust that they will be of some value to you.

Sincerely yours,

A. F. McRorie
Director

OhioEPA

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH 547)
Environmental Protection Agency
401 M. Street, S.W.
Washington, Ohio 20460

July 26, 1978

Dear Mr. Cook:

We are responding pursuant to your request for comments on proposed legislative alternatives for funding combined sewer abatement projects. The 1976 Needs Survey identified costs of approximately 1.8 billion dollars in Ohio for combined sewer projects. Thus the Ohio EPA is extremely interested in any program which increases the federal funding effort in an area so critical to attainment of water quality standards.

It is our opinion that Alternative 4, modifying current law to provide separate funding, is the most feasible and provides the most positive approach to pollution abatement from combined sewer overflows.

Under the present program (Alternative 1) most of the grant monies have been directed to NPDES permit related activities. For the most part these have been directed toward achieving final effluent limitations based on meeting water quality standards during dry weather. Very little has been done to date under the present law to control combined sewer discharges.

It was the intent of P.L. 95-217 to bring some stability to the construction grant program by establishing a long term funding program so the states and the grantees would have a better expectation of future funding levels. It would appear that Alternative 2 runs contrary to this philosophy as it would leave funding entirely at the discretion of the Congress. This has the potential for creating utter chaos in the wastewater planning process.

Alternative 3, calling for nonstructural control techniques, has the potential to significantly increase operation and maintenance costs to local governments for a program with questionable effectiveness. This alternative at a time when local governments are attempting to limit increases in personnel costs is not recommended.

State of Ohio Environmental Protection Agency
Box 1049, 361 E. Broad St., Columbus, Ohio 43216 • (614) 466-8565

James A. Rhodes, Governor
Ned E. Williams, P.E., Director

The facility planning program, as presently developed, is extremely complex requiring months if not years of effort to achieve an end product. It would appear that from Alternative 5, developing multipurpose projects, a program could emerge which would be so unwieldy as to be totally unworkable. In the meantime, progress on combined sewer abatement projects could come to a standstill. Therefore we do not recommend this alternative, either.

As stated previously, we feel that additional emphasis for the combined sewer program is urgently needed and request that it be implemented as expeditiously as possible.

Very truly yours,

Ned E. Williams, P.E.
Director

NEW/ds

cc: Ernie Rotering

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL RESOURCES
POST OFFICE BOX 2063
HARRISBURG, PENNSYLVANIA 17120

August 16, 1978

In reply refer to:
File: 10-1.34

Mr. Michael Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D. C. 20460

Dear Mr. Cook:

This is in response to your request for comments on the legislative alternatives for combined sewer projects.

We believe that Alternative 3 with certain modifications offers the best course of action. Both structural controls and management practices should be considered in planning such a project. However, the management practice component of a project will not be seriously considered unless there are incentives incorporated in the legislative package to share the cost of operation and maintenance associated with these alternatives. The fact that capital expenditure gets subsidized by federal funding will always tilt the scale in favor of capital-intensive measures at the expense of management practices. One possible way to deal with the problem is to subsidize operation and maintenance costs on an annual basis. Such subsidy could take various forms: (a) the management entity (authority, municipality, etc.) is reimbursed a fixed percent of the cost of operation; (b) the management entity or political jurisdiction on behalf of the management entity receives a block grant; (c) taxpayers in the management district receive a tax credit on their individual tax return when they check that a federally approved storm water management plan for the management district/area has been implemented.

We realize there are shortcomings in each of the three forms. However, any other appropriate mechanism to subsidize operation and maintenance costs could be developed and included as a part of the recommended Alternative 3.

Sincerely yours,

Daniel B. Drawbaugh

Daniel B. Drawbaugh, Chief
Division of Water Supply and Sewerage
Bureau of Water Quality Management

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Department of Administration
STATEWIDE PLANNING PROGRAM
265 Melrose Street
Providence, Rhode Island 02907

July 11, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Cook:

I have reviewed Mr. John Rhett's memorandum of July 3 on "Legislative Alternatives for Combined Sewer Projects." As the agency responsible for preparation of long range and system plans for Rhode Island and for conduct of the 208 project in this state, we are directly concerned with correction of the problems created by combined sewers. These exist in Providence, Pawtucket, Central Falls, and Newport.

The five basic legislative alternatives which you outline appear to cover the significant options available, however, only two of these adequately address problems of the type experienced with the combined sewer systems in Rhode Island as noted above. These are Alternatives 1 and 4.

Alternative 1 appears to represent the most simple and direct approach to these problems and to the achievement of the objectives of P.L. 92-500. The problem with this alternative is the lack of a clear policy on the part of EPA as to the availability of future funds for combined sewer abatement projects. I believe that these combined systems must be addressed under the objectives of P.L. 92-500 and that a clarification of EPA's policy toward future funding is urgently needed. If this is not possible, then Alternative 4, which would establish a separate fund for combined sewer abatement projects, could be workable. However, this appears to be more complicated than the policy clarification suggested for Alternative 1.

The three remaining alternatives do not represent valid approaches to the correction of combined sewer systems. The adoption of any one of these alternatives would require that the goals of P.L. 92-500 be substantially modified. The goal of fishable, swimmable waters cannot be met under any of them.

Each of these three latter alternatives presents a different problem. Alternative 2 is simply unworkable from the standpoint of the time and effort which would be required in negotiating funding for each project on a case by case basis. There seems to be no problem in giving Congress a "clear picture" of the costs of combined sewer abatement. Estimates of these costs should be available from the water quality management (303) plans and areawide waste treatment (208) plans which are nearing completion for virtually every combined system. The difficulty with Alternative 3 lies in the lack of feasible nonstructural control techniques for any but the very largest combined systems. No satisfactory nonstructural control techniques, for example, have been identified in an intensive study of the combined system serving Providence. Alternative 5 would make the available funding eligible for so many different activities, including some which have no direct relationship to water quality or combined sewer abatement, that little or nothing would be accomplished in solving the combined system problem. Instead, these funds would be diverted to recreation, urban water supply, or flood control projects, and combined sewer abatement would be deferred for a few more decades.

I hope that this brief review provides the information that you need. Please feel free to contact me if we can be of further assistance.

Yours very truly,

Daniel W. Varin
Chief

DWV/rc

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
75 Davis Street
Providence, R. I. 02908

19 July 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
U.S. Environmental Protection Agency
410 M Street S.W.
Washington, D. C. 20460

Dear Mr. Cook:

This office has reviewed the five proposed Legislative Alternatives for Combined Sewer Projects. It is felt that Alternative #1 "Continue with present law" is the only workable plan. Alternative #2 would only increase the required paperwork, if Congress were needed to make final decisions on each project. Alternative #3 appears to be opening the door to a program which will be very difficult to control. The set aside funds, as referred to in Alternative #4, should not be mandatory and returnable for reallocation if not used by the State. Alternative #5 again is too broad and would dilute this nation's pollution abatement efforts.

This statement is brief and contains the reply requested. Please notify me if any additional alternatives are analyzed.

Yours very truly,

James W. Fester

JWF:ESS:mn

James W. Fester, Chief
Division of Water Resources
Department of Environmental
Management

TEXAS DEPARTMENT OF WATER RESOURCES
1700 N. Congress Avenue
Austin, Texas

TEXAS WATER DEVELOPMENT BOARD
A. L. Black, Chairman
Robert B. Gilmore, Vice Chairman
Milton T. Potts
John H. Garrett
George W. McCleskey
Glen E. Roney

Harvey Davis
Executive Director

TEXAS WATER COMMISSION
Joe D. Carter, Chairman
Dorsey B. Hardeman
Joe R. Carroll

July 14, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Cook:

Re: Proposed Legislative Alternative
for Combined Sewer Projects

In accordance with the Environmental Protection Agency letter of July 3, 1978, subject referenced above, we have reviewed the proposed alternatives and we request that we also be allowed to review the draft study report on funding combined sewer abatement projects when it is completed.

With reference to the alternatives proposed, we feel that combined sewer abatement projects be funded with a national fund authorized by Congress and not be funded with EPA construction grant funds allotted to states.

An additional alternative should be considered as Alternative Number 6 for development of a new law for separate funding for combined sewer overflow projects with multipurpose urban water resource projects. This alternative would be the combination of Alternatives 4 and 5 except EPA construction grant funds for allocation to states would not be used for such projects. Also the Corps of Engineers could administer funds for projects associated with items 2, 5, 6 and 7 under Alternative 5.

If we may be of further service, please do not hesitate to let us know.

Sincerely yours,

Emory G. Long

Emory G. Long, Director
Construction Grants and Water
   Quality Planning

MRR/kd

RAY BLANTON
GOVERNOR

Eugene W. Fowinkle, M.D., M.P.H.
Commissioner

STATE OF TENNESSEE
DEPARTMENT OF PUBLIC HEALTH
NASHVILLE 37219

621 Cordell Hull Building

July 26, 1978

Mr. Michael B. Cook, Chief
Facilities Requirement Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Cook:

The Outline of Legislative Alternatives attached to memorandum dated July 3, 1978 have been reviewed. It appears that the five alternatives cover all possible and acceptable solutions.

We feel that possibly alternative 4 is the preferred alternative since it would provide monies earmarked for the specific purpose and would not take money for sewage treatment plants and interceptors. Alternative 2 would probably be too slow to implement. I don't believe we would have much success with alternative 3 since funding is left to local government. Alternative 5 appears much too complex and includes too many purposes.

If I can be of further service, please call.

Sincerely,

Nolon J. Benson

Nolon J. Benson
Program Coordinator
Division of Water Quality Control

NJB/mk

STATE OF WEST VIRGINIA
DEPARTMENT OF NATURAL RESOURCES
CHARLESTON 25305

DAVID C. CALLAGHAN
Director

July 25, 1978

CERTIFIED MAIL

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401M Street, S. W.
Washington, D. C. 20460

Dear Mr. Cook:

Section 516(c) of the Clean Water Act of 1977 requires that EPA submit by October 1, 1978 a report to Congress on combined sewer overflows. We have just received a list of legislative alternatives that EPA proposes to study in this regard. Our comments on each alternative are herein contained for your consideration.

Alternative 1 - Continue with present law

> "Combined sewer overflow pollution abatement projects would be funded under the existing provisions of P.L. 92-500 as amended in December, 1977 by the Clean Water Act of 1977. Combined sewer overflow control projects would be funded under section 201 of the law."

Under the existing law combined sewer overflow control projects in West Virginia are reviewed and funded on a case-by-case basis with the funding provided from the annual construction grant allocations. There are many I/I analyses and sewer system evaluation surveys presently being conducted in communities in the state. To date, we have had few combined sewer overflow control projects proposed, therefore, only a small amount of our construction grant dollars have been obligated toward these projects (not including I/I analyses and SSES studies). However, in the immediate future as the SSES studies are completed and approved there will be proposed more and more combined sewer overflow control projects that will desire funding from our annual construction grant allocations. With the great need in this state for adequate wastewater treatment and collection facilities, we are reluctant to use our construction grant funds for "other" projects such as combined sewer overflow control. Our comments on Alternatives 3 and 4 to follow express our thoughts relative to the funding aspects of these projects.

Alternative 2 - Modification of current law to provide Congressional funding of larger projects

"Major combined sewer overflow pollution abatement projects would be subject to funding on a case-by-case basis. Once the planning process is complete, each project would be presented to Congress. Congress would have a clear picture of the costs likely to be incurred and the benefits likely to accrue from the plan. The decision whether to fund all of the project, a portion of the project, or none of the project would rest with Congress."

The submission of major combined sewer overflow control projects to Congress on a case-by-case basis for complete or partial approval and the decision by Congress to fund all or part of these projects seems to be a most undesirable alternative. A question in our minds is the EPA definition of "major" and how many projects in West Virginia, if any, would fall into this category. The idea of submitting any individual projects to Congress for approval and funding does not receive our endorsement at all.

Alternative 3 - Modification of current law to provide funding for nonstructural control techniques

"Combined sewer overflow pollution abatement projects may include a mixture of both structural controls and management practices. Management practices consist of those techniques which require very few, if any, capital expenditures. Such operation and maintenance costs are not grant eligible under the current law."

We would support a modification of the existing law to provide funding for nonstructural control techniques, although the implementation of such a program might be difficult. These management practices being grant eligible could assure the efficient use of funds for structural controls. The funding source for these techniques should be a national fund as identified in Alternative 4.

Alternative 4 - Modification of current law to provide a separate funding for combined sewer overflow projects

"Combined sewer overflow pollution abatement projects would be funded from amounts specifically earmarked by Congress for this purpose. The funds could be made available either from a national fund or as a set-aside within each state's allotment of grant funds."

We would approve a modification of the existing law to provide a separate funding source for combined sewer overflow projects given the following condition. A national fund for these projects would be most desirable since this amount of money would be a "add-on" to our annual construction grant allocation. We would not support another set-aside within our annual allotment of construction grant funds for reasons that were previously stated under Alternative 1. There are presently too many set-asides already (i.e. Step 1 and Step 2 reserves, reserve for cost-overruns, set-asides for innovative/alternative technologies, etc.) that deplete funding for much needed projects during the course of a fiscal year. However, we would support an additional funding allotment that would be made available to each state for combined sewer overflow control projects.

Alternative 5 - Development of a new law to provide funding for multipurpose urban water resources projects

"The new legislation would provide for multipurpose urban water resources projects planning and construction funding. The objectives may include: (1) recreation, (2) urban drainage, (3) point source pollution control, (4) control of pollution from combined sewer overflows, (5) control of pollution from urban stormwater runoff, (6) urban water supply including water reuse, and (7) major flood control projects. Funds for those portions of each project which provide substantial benefits relative to costs could be authorized by Congress on a case-by-case basis, or drawn from existing programs such as those administered by EPA, HUD and EDA."

Again projects authorized by Congress on a case-by-case basis seems most unrealistic from our point of view. This alternative seems to be an extension of alternative 2 in that multipurpose urban water resources projects are now being considered with funding being provided by many federal agencies. We would strongly disapprove of this alternative in the same breath as alternative 2.

We hope that when you analyze these alternatives in your report to Congress our comments will be given careful consideration.

Very truly yours,

WATER RESOURCES DIVISION

Mike Johnson

Mike Johnson, Engineer
Construction Grants Section
Municipal Grants Branch

MJ/lt
c: Dave Robinson, Chief, WRD
Bern Wright, Ass't. Chief, WRD
Warren Means, Ass't. Chief-Munic. Grants Branch, WRD

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Anthony S. Earl
Secretary

BOX 7921
MADISON, WISCONSIN 53707

July 26, 1978

IN REPLY REFER TO: 7800

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
EPA
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Cook:

We appreciate being given the opportunity to review the information on Legislative alternatives for combined sewer projects. Although the information is of a preliminary nature, we appreciate the opportunity for input.

While we have no comments on the alternatives mentioned, we would like to stress the impact that any choice could have on our state. The current project now in the planning stages in Milwaukee is estimated to have a cost of $634 million for the combined sewer overflow abatement alone. Legislation affecting level of funding, sources of funding and funding administration could have a great effect on our grant program.

We would welcome the opportunity to comment on draft material in the future as you begin to study the alternatives and make recommendations. We would also appreciate being kept informed as to the status of the report.

Sincerely,
Office of Intergovernmental Programs

Paulette Harder

Paulette Harder, Chief
Grant-in-Aid Section

cc: Paul Guthrie - 14

State of Vermont

AGENCY OF ENVIRONMENTAL CONSERVATION

Montpelier, Vermont 05602
Department of Water Resources

Department of Fish and Game
Department of Forest, Parks, and Recreation
Department of Water Resources
Environmental Board
Division of Environmental Engineering
Division of Environmental Protection
Natural Resources Conservation Council

July 17, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

RE: Legislative Alternatives
for Combined Sewer Projects

Dear Mr. Cook:

We would like to comment on the proposed legislative alternatives for combined sewer projects transmitted under John T. Rhett's July 3, 1978 Memorandum.

Alternative 1 - We endorse this alternative because the institutional arrangements and personnel are currently in place to achieve program accomplishments without reorganizing or refunding.

Alternative 2 - This alternative only discusses major combined sewer overflow projects and leaves funding decisions to Congress. Projects needed for water quality purposes will be subject to loss among other legislative priorities or could be evaluated mostly from an overall government budgetary view point instead of an environmental viewpoint. This alternative should only be developed in conjunction with keeping non-major combined sewer overflow projects fundable under alternative 1.

Alternative 3 - Funding of only non-structural control techniques is only a partial solution. Non-structural control techniques funding should augment structural control funding, not replace it. Continuing benefits from non-structural control techniques will require to a great extent continuing funding to be continusouly effective.

Alternative 4 - This alternative is acceptable provided additional funding is provided by Congress. We specifically oppose creation of further set-asides of construction grant funds for specific purposes. The existing set-asides make priority list management unnecessarily time consuming and difficult, and detract from the states ability to use funds in priority areas of greatest benefit to the states particular water quality needs.

Alternative 5 - This appears too complicated to apply to most projects which have single purpose goals, as is frequently the case in small to medium size communities. This appears to address only large urban areas with a multiplicity of problems. Specific congressional approval would have all the drawbacks mentioned in alternative #2.

I hope these comments have been of assistance to you. Please call us if clarification is required.

Sincerely,

William Brierly for RAL

Reginald A. LaRosa, Director
Environmental Engineering

RAL/sec

New England Interstate Water Pollution Control Commission

607 BOYLSTON STREET • BOSTON • MASSACHUSETTS 02116

617-261-2365
DONALD B. STEVENS, CHAIRMAN
JOAN R. FLOOD, VICE-CHAIRMAN
GEORGE L. BURKE, TREASURER
ALFRED E. PELOQUIN, EXECUTIVE SECRETARY

CONNECTICUT
MAINE
MASSACHUSETTS
NEW HAMPSHIRE
NEW YORK
RHODE ISLAND
VERMONT

July 25, 1978

Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D. C. 20460

Dear Mike:

I have reviewed the legislative alternatives to be studied on funding combined sewer abatement projects as set forth in Jack Rhett's memo of July 3, 1978 and find them all-inclusive. No other alternatives come to mind at the moment. I assume that sufficient flexibility will be maintained in the study to allow for consideration of modified alternatives which may become apparent as the study proceeds.

The Commission would greatly appreciate the opportunity of reviewing the draft report prior to its finalization for Congress.

Sincerely,

Al Peloquin

Alfred E. Peloquin
Executive Secretary

AEP:jpc

LAND-OF-SKY REGIONAL COUNCIL

POST OFFICE BOX 2175 • ASHEVILLE, NORTH CAROLINA 28802
25 HERITAGE DRIVE • TELEPHONE (704) 254-8131

July 18, 1978

Mr. Michael D. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401M Street, SW
Washington, DC 20460

Dear Mr. Cook:

In response to the memorandum of July 3, 1978, from Mr. John T. Rhett, I offer the following recommendations concerning the five basic legislative alternatives outlined for combined sewer overflows.

In general, I believe alternative #3: "Modification of Current Law to Provide Funding for Non-Structural Control Techniques" is a recommendation that should be carried out.

If you are to look at any additional alternatives, I would suggest possibly combining the elements in Alternatives 3, 4, and 5 so that there would be funding for non-structural control techniques and additional funding for combined sewer overflows with case by case funding available for multipurpose urban water resource projects for large urban areas.

Very truly yours,

Robert A Purcell

Robert A. Purcell
208 Project Director

RAP:ds

SERVING REGION B: BUNCOMBE, HENDERSON, MADISON & TRANSYLVANIA COUNTIES

lcog
Lane Council of Governments
NORTH PLAZA LEVEL PSB / 125 EIGHTH AVENUE EAST / EUGENE, OREGON 97401 / TELEPHONE (503) 687-4283

July 21, 1978

Mr. Michael Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M. Street, S.W.
Washington, D. C. 20460

Dear Mr. Cook:

We appreciate the opportunity to comment on the development of "Legislative Alternatives for Combined Sewer Projects."

Our 208 Area has identified Urban Runoff Control as a serious problem needing further attention, even though we are not in an area where serious combined flows exist. Our major metropolitan area of some 150,000 population (sewered) employs separate systems, and only a few surrounding communities have partially connected systems.

For these reasons, that is, because none of the other alternatives have the flexibility or range to deal with situations such as ours, we feel that Alternative 5 represents the best approach.

Urban waters, including streams receiving storm runoff, represent a unique and fragile resource that has many more facets of concern in terms of beneficial use than the subject of "combined sewers" is able to address. It is felt in our area that urban streams and runoff are no longer just a nuisance to be buried and forgotten.

Alternative 1 would be adequate as long as the "alternative" funding guidelines for 201 are applied and as long as other urban runoff control projects are funded separately.

Alternative 2 has some benefits over #1 but still does not address the smaller, but locally important, or noncombined sewer problems.

Alternative 3 is needed but does not seem to address the special funding needs of combined sewer correction that cannot be avoided in all cases.

Alternative 4 seems to be much like #2 in actual impact on projects, although different from an administrative standpoint. Although this procedure reduces competition for funds, it does not particularly support other problem solutions.

Alternative 5 represents the most comprehensive and balanced approach. This is the only legislative approach that specifically addresses the varied beneficial uses of urban water and runoff. Even so, it may still be necessary to divide funding between "combined sewer" and "other" project types and provide special funds for "combined sewer" correction as well as incentives for nonstructural approaches.

Again, thank you for the opportunity to comment.

Sincerely,

Gerritt Rosenthal

Gerritt Rosenthal
208 Program Manager

GR:rl/F1&2

GREATER PORTLAND
COUNCIL OF GOVERNMENTS
331 VERANDA STREET · PORTLAND, MAINE 04103 · 207-774-9891

mber
nicipalities

Bridgton
ape Elizabeth
Casco
Cumberland
Falmouth
Freeport
Gorham
Gray
Naples
Portland
Pownal
Scarborough
Sebago
outh Portland
Westbrook
Windham
Yarmouth

July 11, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch(WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Cook:

This letter is to provide comments on the combined sewer overflow control legislative alternatives outlined in the attachment to John Rhetts' memorandum of July 3, 1978. The comments are directed principally at the structure of the proposal rather than at providing advice as to the preferred approach.

The alternatives proposed do not appear to represent a single continuum of responses. One continuum appears to provide increasing congressional control (Alt.#1 Alt.#4 Alt.#2 Alt.#5). Alternative #3 appears to define a point on another continuum providing for a more open funding posture for non-structural controls. The result is that the alternatives are not mutually exclusive. This topic is complex, and I suggest that a presentation which does not clearly identify the range of policy choices available for each of the issues to be addressed will only further the problems Congress obviously had with the program.

The two issues addressed in the alternatives outline are:

- congressional control
- funding for structural vs. funding for non-structural pollution abatement

Other issues which occur to me are:

- funding for small, private source controls vs. funding for larger, centralized, public controls
- seasonal vs. continuous permit requirements

I am sure that with national input the list of issues will grow. The suggestion is to identify the significant issues in this program and to define a continuum of responses for each and then to define a process whereby Congress can pick an appropriate package of responses.

Thank you for the opportunity to provide these comments.

Sincerely,

Eric A. Root

Eric A. Root, Director
Water Resources Planning

EAR/pl

Enclosure

cc: Bill Goodwin, City of Portland
Roy Spugnardi, City of South Portland
Ed Reidman, City of Westbrook

metropolitan washington
COUNCIL OF GOVERNMENTS
1225 Connecticut Avenue, N.W., Washington, D. C. 20036 223-6800

July 19, 1978

Mr. Michael E. Cook, Chief
Facility Requirements Branch (WH-547)
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Cook:

In response to request from Mr. John T. Rhett dated July 3, 1978, seeking responses to the proposed Legislative Alternatives for Combined Sewer Project, I would like to make the following comments:

1. Under Alternative 2, some limitation or definition of a "major" project needs to be identified. This can be defined in terms of a percentage of annual state allocation for Construction Grants or in dollars.

2. Alternatives 3 and 4 would only perpetuate the need for more guidelines, regulations, and ensuing confusion by grant applicants and administrators. Both of these alternatives should be included in your Alternative 5.

Should you need clarification or expansion of any of the comments above, please let me know. You may reach me by phone on Extension 386 at the above number.

Sincerely,

K. Kenneth Fujishiro, AIP
Chief, Water Pollution Control
Department of Water Resources

f Columbia • Arlington County • Fairfax County • Loudoun County • Montgomery County • Prince George's County • Prince William County
Alexandria • College Park • Fairfax City • Falls Church • Gaithersburg • Greenbelt • Rockville • Takoma Park

Northwestern Indiana
Regional
Planning Commission
8149 Kennedy Avenue (219) 923-1060
Highland, Indiana 46322 (312) 731-2646

JACK R. CLEM - Chairman
Porter County Councilman

R. ATTERSON SPANN - Vice-Chairman
Lake County Commissioner

WILLIAM A. FISCHER - Secretary
Town Board, Kouts

VERNON SEGERT - Treasurer
Crown Point City Councilman

DONALD L. COPE - Executive Bd.
Town Board Pres., Porter

CLARK A. METZ - Executive Bd.
Lake County Councilman

WILLIAM S. TANKE - Executive Bd.
Porter County Surveyor

GEORGE H. WILLIAMS - Executive Bd.
Director of Development
& Planning, City of Gary

ALEX DREMONAS - Executive Bd.
NWI Representative - Indiana
Coastal Zone Management Pgm.

RICHARD D. BELL
Town Board, Hebron

WILLIAM R. CARMICHAEL
Porter County Commissioner

DANIEL M. COLBY
Town Board, Griffith

OREAL J. CREPEAU
Ass't to President
General Office, Inland Steel

RAYMOND R. FLACHBART
Director of Dept. of Development
& Planning, City of Hammond

ROBERT FREELAND, Jr.
President - Gary City Council

TIMOTHY P. GALVIN, Jr.
Munster

Calvin E. Green, Jr.
Mayor, Hobart

ROBERT E. GOIN
Mayor, Portage

ELDEN KUEHL
Mayor, Valparaiso

WILLIAM KURTIS
Town Board, Merrillville

COLIN S. MACKENZIE
Ogden Dunes

JOHN MELCHIORI
Town Board, Chesterton

ROBERT A. PASTRICK
Mayor, East Chicago

EDWARD J. RASKOSKY
Mayor, Hammond

GEORGE W. VAN TIL
Town Board, Highland

NORMAN E. TUFFORD
Executive Director

July 18, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M. Street, S.W.
Washington, D.C. 20460

Subject: Comments on Legislative Alternatives for Combined Projects

Dear Mr. Cook:

The Environmental Management Committee of the Northwestern Indiana Regional Planning Commission and support staff have reviewed the CSO Alternatives and offers the following comments:

- Alternative 1 - Continue with present law.
  Comment: Inadequate level of funding; no initiative for states to concentrate on serious CSO problems.

- Alternative 2- Modification of current law to provide Congressional funding of larger projects.
  Comment: The concept would put the decision to fund or not to fund in the hands of Congress. This concept is a long drawn out process and would tend to slow down plan implementation of 208 WQM Plans and 201 F.P. recommending CSO corrections.

- Alternative 3 - Modification of current law to provide funding for non-structural control techniques.
  Comment: While funding O/M costs for non-structural controls would be an improvement the alternative just does not go far enough to address all the problems.

Michael B. Cook, Chief
Page Two
July 18, 1978

- Alternative 4 - Modification of current law to provide a separate funding for combined sewer overflow projects.

  Comment: This alternative has possibilities, however, the alternative does not include urban storm water projects. Funding should be at sufficient levels to be meaningful.

- Alternative 5 - Development of a new law to provide funding for multipurpose urban water resources projects.

  Comment: This alternative has the greatest potential for providing funding of sorely needed urban water resource improvements. The authorization by Congress on a case-by-case basis should be deleted. Existing programs such as those administered by EPA, HUD, and EDA should also include U.S. Army Corps of Engineers, Water Resource Council, U.S.D.A. and other Federal Agencies having programs dealing with environmental issues. NOTE: Program requirements should not duplicate existing requirements, but should build on past programs with the objectives of improving and/or providing funding for plan of study, design and construction where gaps now exist. Consideration should also be given to industrial waste water treatment and potential funding.

In addition to the comments on proposed legislative changes, I call your attention to NIRPC's 208 Water Quality Management Plan costs:

• Municipal Waste Water Improvements	$248 million
• Combined Sewer Projects	$217 million
• Storm Sewers and Urban Runoff	$6.5 million
• Industrial Treatment Improvements	$2.4 billion
• Non-Point Agricultural Runoff	$ 67 million

These improvements are proposed for only two (2) of Indiana's 92 counties. The current population is some 630,000 and land area of 915 square miles.

Future legislation should consider funding levels that would not only enable improvements to be made, but at levels and time periods to insure implementation of the Clear Water Act goals.

Should you have any questions, please contact John J. Janik, Chief, Water Quality Management Planning at 219-923-1060.

Very truly yours,

William R. Carmichael

William R. Carmichael, Chairman
Environmental Management Committee

WRC/JJJ/dkj

Southeast Michigan Council of Governments
800 Book Building · Detroit, Michigan · 48226 · (313) 961-4266

July 20, 1978

Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

Dear Mr. Cook:

We are writing pursuant to the request of John E. Rhett for comments on the five basic legislative alternatives to be analyzed by EPA regarding combined sewer overflows.

Firstly, we feel that a modification of the existing law would be preferable to the development of a new law. Over the past three years we have established an awareness in this region as to goals of the "Clean Water Act" and the implication of "Section 208," "System 201," etc., and it would be better to expand programs within this framework rather than establish a new one.

Secondly, any modifications should definitely include funding a range of non-structural control techniques which prove cost-effective vis-a-vis major capital expenditures; (e.g., although it would not necessarily involve combined sewer situations, we have found instances where the purchase and relocation of structures would be the most cost-effective way of removing a pollution problem as opposed to the construction of new facilities, but we are unable to utilize 201 funds at present for such an option. This, in effect eliminates this option since 100% local funding is not feasible.)

Thirdly, there is a need for the funding of multipurpose urban water resource projects as suggested in your alternative five.

Your file alternatives cover all of the above, but we are perhaps suggesting a sixth alternative that would amend the existing law to allow for the funding of nonstructural and multipurpose projects under a new section. Further, although allowing Congress to have final decision over individual projects would have some political appeal, we question whether this would be an effective way of choosing the best alternative to solving specific

DAVID H. SHEPHERD, Chairperson
Mayor, City of Oak Park

ROBERT L. BOVITZ, Vice Chairperson
Mayor, City of Trenton

LAWRENCE R. PERNICK, Vice Chairperson
Commissioner, Oakland County

ROBERT E. SMITH, Vice Chairperson
President, Livingston
Intermediate School District

MARY ELLEN PARROTT, Vice Chairperson
Treasurer, Shelby Township

KATHLEEN M. FOJTIK, Vice Chairperson
Commissioner, Washtenaw County

MICHAEL M. GLUSAC, Executive Director

local pollution problems. Combined sewers are an integral part of the overall water pollution problem in most metropolitan areas, and it is preferable to have as few sources and methods of funding as possible.

Sincerely,

Michael M. Glusac
Executive Director

MMG/tb

VNRC
VERMONT NATURAL RESOURCES
COUNCIL

July 11, 1978

Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

RE: Legislative Alternatives for Combined Sewer Projects

Dear Mr. Cook:

This letter is in response to John Rhett's memo of July 3 requesting comments on legislative alternatives for funding combined sewer abatement projects. I have a few small comments to share.

Alternative 2 fails to say anything about "minor" projects. Would they be funded under existing provisions of Section 201, or not funded at all? I think it is important to address funding of minor projects as well as major ones, for what is "minor" to EPA may [illegible] have a major impact in the community itself.

Alternative 3 doesn't say whether it would take place under Section 201 or through some other funding mechanism. Personally, I think funding management practices would be an excellent idea, but they might receive little serious consideration under the 201 program as it is now conducted.

Alternative 5 fails to address the problem of rural projects. I hope EPA realizes that combined sewer overflows are as serious a problem in some rural communities as in urban cities. Would this alternative be available to rural towns, also?

On Alternative 5, I think you will need to be much more specific about the process by which communities could use funds "from existing programs such as those administered by EPA, HUD, and EDA." I believe the success or failure of such an approach would depend in large part on whether it increases the "red tape" which towns would have to go through in order to carry out projects.

Thank you for this opportunity to comment. I hope these questions are helpful to you in your efforts.

Sincerely,

Michele Frome

Michele Frome, Director

26 STATE STREET, MONTPELIER, VERMONT 05602 TELEPHONE (802) 223-2328

NICHOLAS J. MELAS
PRESIDENT

THE
METROPOLITAN SANITARY DISTRICT
OF GREATER CHICAGO
100 EAST ERIE ST., CHICAGO, ILLINOIS 60611 751-5600

Bart T. Lynam
General Superintendent
751-5722

BOARD OF COMMISSIONERS

JOANNE H. ALTER
JEROME A. COSENTINO
DELORIS M. FOSTER
WILLIAM A. JASKULA
NELLIE L. JONES
JAMES C. KIRIE
CHESTER P. MAJEWSKI
NICHOLAS J. MELAS
RICHARD J. TROY

July 17, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

SUBJECT: Legislative Alternatives for Combined Sewer Projects

Dear Mr. Cook:

Per Mr. Rhett's request of July 3, 1978 on the subject topic, I have reviewed the five alternatives proposed and have a couple of suggestions relative thereto.

It is my opinion that Alternative 1 should be retained as the principal mechanism for dealing with water pollution attributable to combined sewer overflows. It places such projects in the proper perspective of PL/92-500 and the Clean Water Act of 1977. Competition for federal funding of such projects under state priority guidelines assures that the pollution attributable to such sources is compared with pollution from other sources and placed at the proper priority level.

A modification of Alternative 5 which would provide a mechanism for coordinating all other urban drainage and runoff control projects with the pollution control aspects should be considered. Our experience in the Chicago area indicates that achievement of pollution control aspects of combined sewer overflows and other polluting discharges from urban areas can provide cost savings at all levels of government. Funding provisions which would allow resolution of other urban water management problems in cooperation with water pollution control problems while retaining the independence of the water pollution control projects is desirable. Retention of the Alternative 5 as proposed would probably result in combined projects being subjected to an overall cost/benefit analysis which could override the necessity for eliminating water pollution as directed by the Clean Water Act. Additionally, the relatively long period required to obtain approvals of flood control and drainage projects could significantly impede progress towards elimination of water pollution.

We are critically aware of the lack of federal precedence for funding of urban drainage projects and would therefore support a program which addresses these problems with evaluation criteria and funding mechanism.

Very truly yours,

Bart T. Lynam

Bart T. Lynam
General Superintendent

BTL:HM:sbs
cc: Mr. Ron Linton - AMSA

CLEVELAND REGIONAL SEWER DISTRICT
801 ROCKWELL • CLEVELAND OHIO 44114 • TEL 216 781-6600

ANDREW T. UNGAR
DIRECTOR

July 25, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D. C. 20460

Dear Mr. Cook:

Re: Legislative Alternatives for
Combined Sewer Projects

We have reviewed the July 3, 1978, list of legislative alternatives. The list includes those options of relevance to combined sewer overflow (CSO) projects. We believe EPA has a unique opportunity to advise Congress about the varied and complex pollution and drainage issues confronting residents of the urban environment. The urban need for adequate storm drainage and combined sewer overflow control facilities is well documented. The central question is the source of funding to not only abate pollution from CSO's, but also to alleviate storm water damages. EPA can do much to focus Congressional interest in these problems.

We offer the following comments as issues which should be considered during the analysis of the legislative alternatives:

ALTERNATIVE 1. Continue with present law.

We believe the present situation is undesirable, due to the low priority assigned to CSO projects by many state priority systems. Also, the guidance for funding CSO's has prescribed limits which has served, in some cases, to defer needed wet weather outlet sizing.

The present situation should not be viewed as acceptable without increased EPA funding flexibility and improved priority ranking for CSO projects. In essence, Alternative 4 is a more desirable approach.

ALTERNATIVE 2. Modification of current law to provide Congressional funding of larger projects.

A definition of "major combined sewer overflow pollution abatement projects" is needed. We would assume that large cost projects, including storm water handling elements would be included in this definition.

A case-by-case project funding by Congress would clearly show Federal interest and involvement in the urban drainage and pollution issues.

A concern is that the historical EPA emphasis on rational demonstration of the need for a project may become lost in such a cumbersome decision-making process.

ALTERNATIVE 3. Modification of current law to provide funding for nonstructural control techniques.

The funding of BMP will not alleviate the need for structural CSO projects in most urban areas. It is our experience that implementation of BMP activities will not by itself significantly reduce pollution from urban run-off, although BMP can serve an adjunctive role in a structural pollution abatement program. We are concerned that previous planning and design for CSO control would be significantly delayed, while BMP requirements are studied. We believe that BMP implementation would accrue only marginal results, while subjecting necessary structural control projects to the significant effects of inflation.

EPA should be vary cautious about recommending another set of planning requirements which add little to the problem solving process. Also, we are concerned that labor intensive programs, such as BMP may be perceived by the taxpayer as a "luxury" program when compared to other services and maintenance of existing structural facilities.

ALTERNATIVE 4. Modification of current law to provide a separate funding for combined sewer overflow projects.

In an approach limited to the pollution abatement aspect of the urban combined sewer problem, this alternative warrants the most serious consideration. The merits of either a national fund or a mandatory set-aside for state allotments seem equally subject to debate. While the precedent for a set-aside exists and could be easily implemented, we are concerned that such an approach could be used to defer facing the magnitude of the CSO need element in the swimmable, fishable goals of the Act. A separate national fund represents a true commitment to abate CSO pollution, but may conflict with Federal economy measures. EPA should point out to Congress that the actual conflict is between CSO needs and the goals of the Act. A compatible solution would be an assured level of CSO control funding projected over a realistic timetable to achieve the goals of the Act for this pollution source. We therefore recommend a minimum level set-aside based upon the proportion of CSO needs to the state allotment. Further, CSO compliance scheduling should reflect the maximum time required to complete construction based on the minimum level of annual CSO funding.

We also recommend that EPA reassess PRM 75-34, in order to provide additional flexibility in those cases where an increase in wet weather outlet capacity will achieve benefits in storm water damage reduction.

ALTERNATIVE 5. Development of a new law to provide funding for multipurpose urban water resources projects. While this may ultimately become the method by which to resolve urban water resource problems, we are concerned that such an approach would result in significant delays in the construction of those presently designed CSO projects. We do not believe that the public's best interest is served by deferring CSO pollution abatement until such legislation is enacted and an implementing Federal structure is created.

We believe that at the present time each Federal agency involved in urban water resource problems has established an array of complex regulations and mechanisms in an attempt to minimize their roles in solving these serious problems. It is obvious that a remedy for the present fragmentation of urban water resource efforts is needed. However, we believe that additional study is required before the roles of each Federal agency can be properly assessed, and an effective program established. EPA can achieve much by reporting to Congress on the present situation and by pointing out the need for a comprehensive study.

We appreciate the opportunity to comment on the legislative alternatives, and we are available to provide any of our information which may be of use to you. We look forward to reviewing your draft report, and we would appreciate being placed on your distribution list for the CSO study documents.

Very truly yours,

Andrew T. Ungar, Director
CLEVELAND REGIONAL SEWER DISTRICT

ATU/inc

cc: AMSA

the Evergreen
CITY OF
everett
3200 CEDAR • 259-8821
EVERETT, WASHINGTON
98201
DEPARTMENT OF UTILITIES

July 26, 1978

Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

LEGISLATIVE ALTERNATIVES FOR COMBINED SEWER PROJECTS

Dear Mr. Cook:

We suggest that a sixth alternative be considered for analysis in your report. This alternative would be as follows:

Alternative 6 - Modification of current law to allow a lower level of treatment for combined sewer overflows (concentrators with post disinfection) and continue with present funding.

At the present time, many combined sewer overflow projects cannot be justified under PG-61 requirements for funding. The result has been that all or nothing is done. This alternative would allow for the construction of combined sewer overflow projects which do not meet secondary treatment standards but which provide sufficient pollution control abatement and which are financially feasible under the current funding program.

We hope that this suggestion will be given favorable review and we thank you for this opportunity to comment.

Sincerely,

Marvin C. Haglund

Marvin C. Haglund
Director of Utilities

cc: Craig Thompson, Sewer Superintendent

METROPOLITAN SEWERAGE DISTRICT
OF THE COUNTY OF MILWAUKEE
P.O. BOX 2079 MILWAUKEE, WISCONSIN 53201
PHONE 271-2403

Sewerage Commission of the City of Milwaukee · Metropolitan Sewerage Commission of the County of Milwaukee

July 17, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mike:

I am writing in response to your request for comments on the five basic legislative alternatives dealing with combined sewer overflows. I believe that legislation to provide funding for multi-purpose urban water resources projects will have the greatest benefit not only to a community like Milwaukee, but also other communities. As you know, here in Milwaukee we are faced with a huge expenditure to deal with our combined sewer overflows. However, the pollution entering the waterways through this source is but a fraction of the total pollution load received by the rivers and by Lake Michigan. For example, the combined sewer pollution load entering the Milwaukee River is only 25% of the total load coming into the Milwaukee River. While we believe a significant improvement in water quality can be achieved through interception of the combined sewer overflows, it is obvious that the other sources must also be dealt with to achieve further improvements in water quality.

In addition, there are problems of stormwater carrying a large amount of pollutants which are not being dealt with, and with pollutants entering the District from drainage outside of the District. This is coupled with flooding problems which face us. Our flood control channels system needs a great deal of planning and improvements. A combination of these problems together with our dry weather flow dictate a problem-solving approach that includes an integration of all sources of drainage.

There is no question but that adequate funding for urban drainage problems must be made available if we are serious about improving the water quality in urban areas. Certainly, this is true here in Milwaukee. I highly recommend that the funds for this program be administered by appropriate agencies rather than be considered by Congress on a case-by-case basis. By its very nature, the Congressional process is necessarily slow and will result in major time delays.

Respectfully,

William J. Katz
Director, Technical Services

WJK:sl

cc: J. Wesselman
D. G. Wieland
C. V. Gibbs

**VENTURA REGIONAL
COUNTY SANITATION DISTRICT**

**JOHN A. LAMBIE
CHIEF ENGINEER
GENERAL MANAGER**

BER AGENCIES
TURA COUNTY
ES
arillo
nore
rd
Hueneme
Buenaventura
a Paula
Valley
usand Oaks
CIAL DISTRICTS
arillo Sanitary
rosa
nty Water
nnel Islands
nty Water
ers Oaks
tary
talvo Municipal
rovement
rpark County
tation
View Sanitary
roy Sanitary
Valley County
tation
h Coast County
tation
h Coast County
r Maintenance
nfo County
tation
ura Avenue
tary
ura County
rworks Districts
1, 16 and 17

July 26, 1978

United States Environmental
Protection Agency
Washington, D.C.

Attention: Mr. Michael B. Cook, Chief
Facility Requirements Branch

Subject: LEGISLATIVE ALTERNATIVES FOR
COMBINED SEWER PROJECTS

Dear Mr. Cook:

Thank you for your request for comments on legislative alternatives to be studied in your report to Congress.

In consideration of the five alternatives offered for comment and keeping the Ventura Regional County Sanitation District's needs in mind, I would say that Alternative 5 has the most benefit. This is the alternative for development of a new law to provide funding for multipurpose urban water resources projects.

Very truly yours,

John A. Lambie

John A. Lambie
Chief Engineer-General Manager

JAL:ss

Mailing Address: P.O. BOX AB 93001 • VENTURA, CALIFORNIA • 290 MAPLE COURT (805) 659-2130

american
concrete
pipe
association

July 31, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
U. S. Environmental Protection Agency
401 M Street, S.W., Room #1137
Washington, D.C. 20460

Dear Mike:

In reply to Jack Rhett's memorandum of July 3rd on "Legislative Alternatives for Combined Sewer Projects," requesting comments on the proposed five basic alternatives, our Government Relations Committee met on July 24th and selected "Alternative #1 - Continue With Present Law."

Our selection of Alternative #1 was based on Doug Costle's response to Congressman Oberstar's question at the Oversight Hearing of July 13th, when he was asked what the states would do with their funds after secondary treatment is fully implemented. Administrator Costle stated that in order to avoid reallocation of their funds, they would have to re-establish their priorities and that separation of combined systems and additional sanitary needs would become even more necessary. If the Administrator follows his statement of July 13th, then Alternative #1 appears to be the logical choice since both Public Laws 92-500 and 95-217 reinforce these eligibility categories.

If there are any additional meetings on this subject, prior to your submittal to Congress by October 1st, we would appreciate your notifying us.

Very truly yours,

Cy

Cyril I. Malloy
Vice President of Government Relations

CIM:jb
cc: Burr Allegaert
John O. Wagner

8320 old courthouse road • vienna virginia 22180 • (703) 821-1990

THE JENNINGS-LAWRENCE COMPANY 555 Buttles Avenue Columbus, Ohio 43215 (614) 228-3846

August 3, 1978

Mr. Michael B. Cook, Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S. W.
Washington, D. C. 20460

Re: Legislative Alternatives
Combined Sewer Projects

Dear Sir:

We have given some thought to the various alternatives in your Memo of July 3, 1978 and offer the following comments.

Alternative 5 seems to add yet another program with a new set of directives, priorities and staff. We do not view this as an attractive solution.

Alternative 2 suffers from the need to define and then work around the title "Major projects". This could well work to deliberately delay a job.

Alternative 1 may well be operable within present funding levels.

Alternative 3 is attractive, for we believe it entirely possible that capital intensive projects might be initiated when maintenance would be more cost-effective, if maintenance costs became eligible for permanent funding.

Alternative 4 is, in our opinion, the more desirable route, but not as a set-aside. Overflow projects should be funded to the extent appropriations are made for that purpose, not extracted from pollution control funds.

Yours truly,

THE JENNINGS-LAWRENCE COMPANY

Carl C. Walker, Jr.

CCW,Jr.:m

Established 1917

DEPARTMENT OF DEFENSE

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO
ATTENTION OF:
DAEN-CWE-BU

14 AUG 1978

Mr. Michael B. Cook
Chief
Facility Requirements Branch (WH-547)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Cook:

We have reviewed the set of alternatives contained with the memorandum "Legislative Alternatives for Combined Sewer Projects" dated 3 July 1978. We believe most alternatives have been included in the set presented; however, one more should be added.

The set of alternatives that is evaluated should include those that cover existing Federal programs. A combination of alternatives two and five would describe our ongoing Urban Studies program and should be added to the list. If desired, we can participate in further development of this alternative or in evaluation of the total set.

When information described in the first five items of Section 516(C) of the Clean Water Act is available, a more thorough evaluation of the set of alternatives will be possible.

Sincerely,

HUGH G. ROBINSON
Brigadier General, USA
Deputy Director of Civil Works

APPENDIX B
COMPARISON OF POLLUTANT DISCHARGES FOR 15 CITIES

Comparison of pollutant discharges from three sources for 15 cities is presented in this appendix. The sources considered are urban stormwater runoff, combined sewer overflow, and secondary wastewater treatment plant effluent. Pollutant loadings are compared on an average annual basis and on a runoff event basis. Since three pollutant sources are compared, a source is termed major if it accounts for more than one-third of the pollutants discharged during the time period of comparison. Conversely, a source is termed minor if it accounts for less than one-third of the pollutants discharged during the time period of comparison. The term "Urbanized Area" refers to the definition used by the Bureau of the Census of the U.S. Department of Commerce to establish the location and extent of urban areas. A total of 279 Urbanized Areas were defined by the Bureau of the Census in 1975.

BOSTON, MASSACHUSETTS

Urban Characteristics

The Metropolitan Sewerage District of Boston serves 43 municipalities with a drainage area of 331,410 acres (517.8 square miles) and a 1970 population of 2,153,000. A wastewater management plan for the Eastern Massachusetts Metropolitan Area (EMMA) modeled a combined sewer drainage area of 24,370 acres (38.1 square miles) in Boston which is essentially 100% developed and has an average population density of 35.9 people per acre. The total combined sewer drainage area is approximately 28,000 acres (43.8 square miles). Combined sewer overflow occurs approximately 60 times per year at over 100 locations on the Charles River, Mystic River, and Chelsea River and into Boston Harbor and Dorchester Bay. These overflow events cause beach closings and restricted shellfishing in the receiving waters and are documented to be the primary water pollution control priority for the area. Two primary wastewater treatment plants (WWTP) have a design capacity of 455 mgd and treat an average daily flow of 402 mgd which is discharged into Boston Harbor. In addition, two combined sewer overflow treatment facilities provide detention and chlorination for a design flow of 390 mgd.

The average annual rainfall in Boston is 41.5 inches, ranging from an average monthly low of 3.13 inches in June to a high of 3.85 inches in March and November, as shown in Figure B-1. Rainfall occurs for approximately 780 hours per

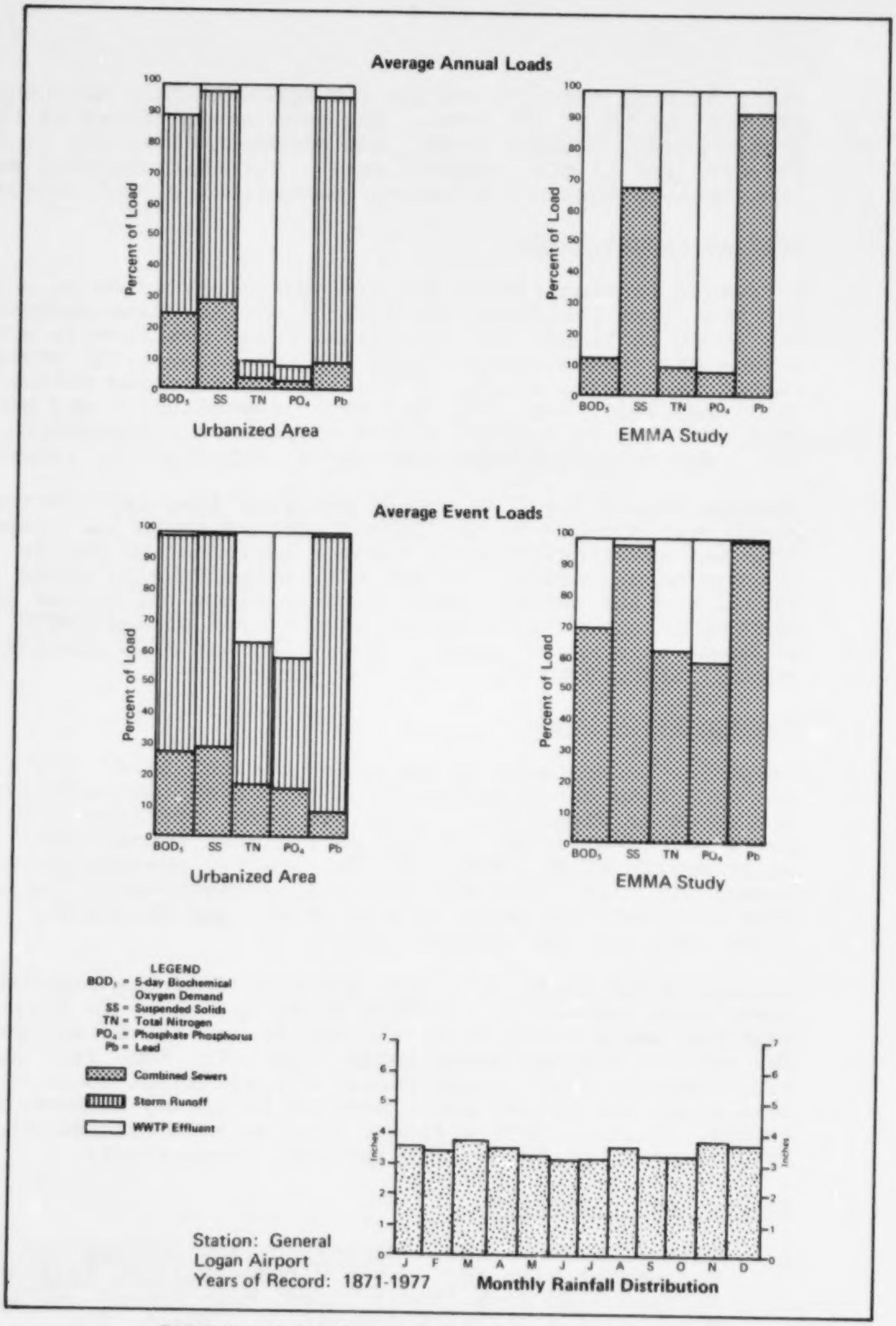


FIGURE B-1. Loading comparison for Boston, Massachusetts.

year, causing overflow events for approximately 525 hours per year or 5% of the time. The mean annual flows of the Mystic River, Charles River, and Neponset River are 31 cfs, 294 cfs, and 46 cfs, respectively. Present receiving water uses include boating, swimming, shellfishing, and navigation.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Boston, Massachusetts, are shown in Figure B-1. Combined sewer overflow is a minor source of average annual loads for all parameters; storm runoff is a major source of lead (Pb), suspended solids (SS), and BOD_5, 88%, 70%, and 64%, respectively; and secondary WWTP effluent is a major source of phosphate phosphorus (PO_4) and total nitrogen (TN) loads, 92% and 91%, respectively.

Average annual loads in pounds per year from the combined sewer area modeled by the EMMA Study are shown in Figure B-1. Combined sewer overflow is a major source of Pb and SS average annual loads, 91% and 69%, respectively; storm runoff average annual loads are zero since the entire basin modeled is served by combined sewers; and primary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 92%, 90%, and 88%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Boston, Massachusetts, are shown in Figure B-1. Combined sewer overflow is a minor source of event loads for all parameters; storm runoff is a major source of Pb, BOD_5, SS, TN, and PO_4 average event loads, 91%, 71%, 71%, 45%, and 41%, respectively; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 42% and 38%, respectively.

Average event loads in pounds per hour from the combined sewer area modeled by the EMMA Study are shown in Figure B-1. Combined sewer overflow is a major source of Pb, SS, BOD_5, TN, and PO_4 average event loads, 99%, 97%, 69%, 64%, and 59%, respectively. Storm runoff average event loads are zero since the entire basin modeled is served by combined sewers. Primary WWTP effluent is a major source of PO_4 and TN average event loads, 41% and 36%, respectively.

Sources of Information

1. Metcalf & Eddy, Inc. Wastewater Engineering and Management Plan for Boston Harbor--Eastern Massachusetts Metropolitan Area (EMMA) Study, Main Report for the Metropolitan District Commission. March 1976.

2. Metcalf & Eddy, Inc. Wastewater Engineering and Management Plan for Boston Harbor--Eastern Massachusetts Metropolitan Area (EMMA) Study, Technical Data, Volume 7, Combined Sewer Overflow Regulation. November 1975.

3. Personal communication: John R. Elwood, Supervising Sanitary Engineer, Metropolitan District Commission, Environmental Planning Office.

NEW YORK, NEW YORK

Urban Characteristics

The five boroughs of New York comprise a land area of approximately 205,000 acres (320.3 square miles) with a combined sewer drainage area of 184,615 acres (288.5 square miles) and a 1970 population of 7,614,500. Population is not expected to change during the next 20 years since 90% of the City's area is presently developed. Combined sewer overflow occurs approximately 100 times per year at over 700 locations on the Hudson River, in New York Harbor, and in Long Island Sound. These overflow events cause bacterial contamination of swimming beaches and shellfishing areas. Twelve WWTP's provide primary treatment or better to a design dry-weather flow of 1,030 mgd, and two additional municipal service areas discharge 210 mgd of raw sewage into New York Harbor.

The average annual rainfall in New York is 43.7 inches, ranging from an average monthly low of 3.35 inches in January to a high of 4.33 inches in August, as shown in Figure B-2. Approximately 114 rainfall events occur each year with an average duration per event of 6.33 hours. Therefore, rainfall occurs for approximately 722 hours per year causing runoff for approximately 433 hours per year or 4.9% of the time. Receiving water uses include navigation and, in restricted areas, fishing, swimming, and other recreational activities.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of New York are shown in Figure B-2. Combined sewer overflow is a major source of SS and Pb annual loads, 74% and 46%, respectively. Storm runoff is a major source of the average annual load for Pb, 44%, and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 95%, 94%, and 65%, respectively.

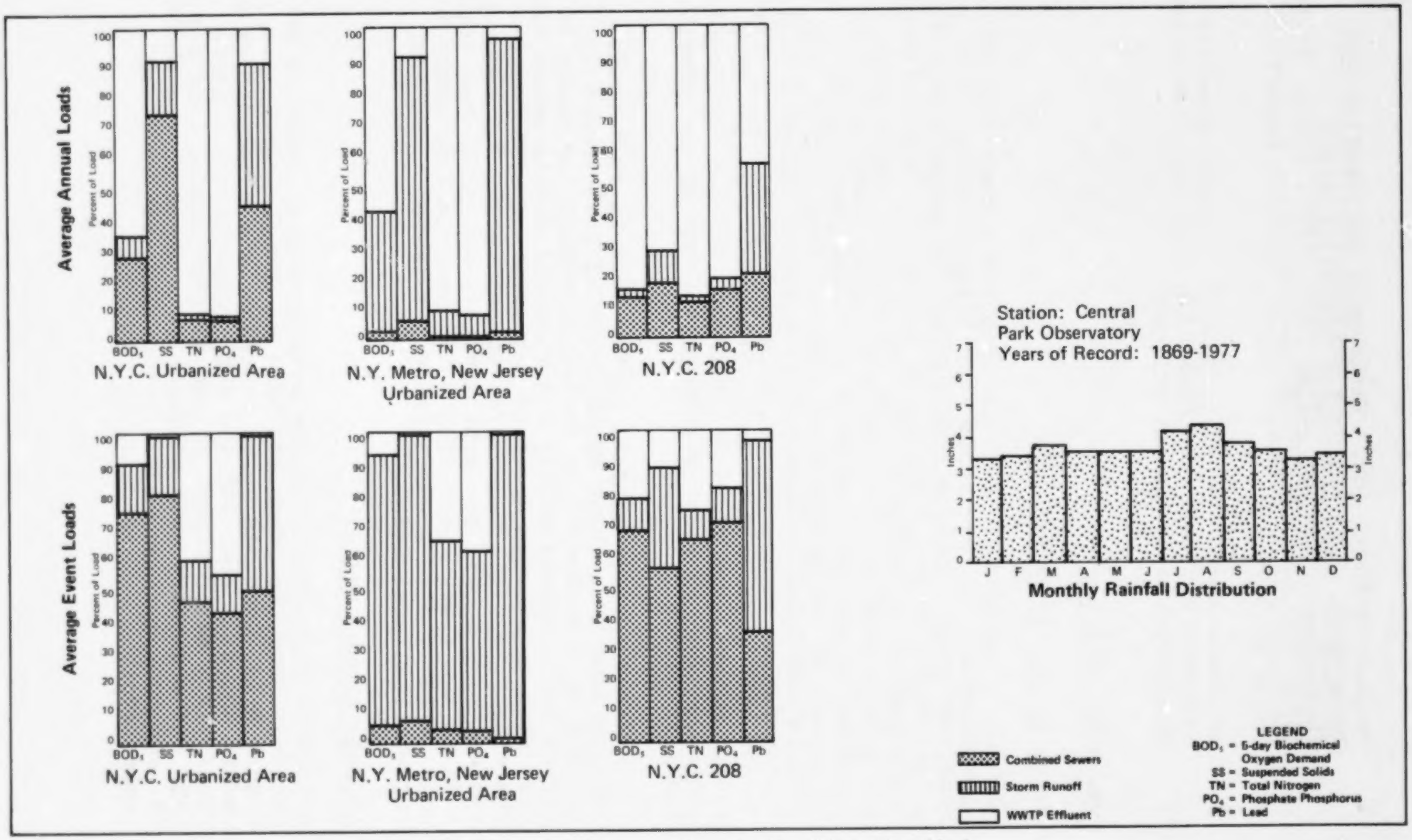


FIGURE B-2. Loading comparison for New York, New York.

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of New York Metro New Jersey are shown in Figure B-2. Combined sewer overflow is a minor source of average annual loads for all parameters. Storm runoff is a major source of Pb, SS, and BOD_5 average annual loads, 96%, 87%, and 39%, respectively; and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 93%, 92%, and 58%, respectively.

Average annual loads in pounds per year from the area modeled by the New York 208 for baseline conditions are shown in Figure B-2. Combined sewer overflow is a minor source of average annual loads for all parameters. Storm runoff is a major source of the average annual load for Pb, 35%; and baseline WWTP effluent is a major source of total kjeldahl nitrogen (TKN), BOD_5, PO_4, SS, and Pb average annual loads, 88%, 85%, 82%, 72%, and 44%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of New York are shown in Figure B-2. Combined sewer overflow is a major source of SS, BOD_5, Pb, TN, and PO_4 average event loads, 81%, 74%, 51%, 47%, and 44%, respectively. Storm runoff is a major source of the average event load for Pb, 49%; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 46% and 42%, respectively.

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of New York Metropolitan New Jersey are shown in Figure B-2. Combined sewer overflow is a minor source of average event loads for all parameters. Storm runoff is a major source of Pb, SS, BOD_5, TN, and PO_4 average event loads, 99%, 94%, 89%, 61%, and 57%, respectively; and WWTP effluent is a major source of PO_4 and TN average event loads, 40% and 36%, respectively.

Average event loads in pounds per hour from the area modeled in the New York 208 for baseline conditions are shown in Figure B-2. Combined sewer overflow is a major source of PO_4, BOD_5, TN, SS, and Pb average event loads, 71%, 68%, 67%, 57%, and 36%, respectively. Storm runoff is a major source of the average event load for Pb, 60%; and baseline WWTP effluent is a minor source of the average event load for all parameters.

Sources of Information

1. New York City Department of Environmental Protection, Areawide Waste Treatment Management Planning Program, Executive Summary. March 1978.

2. Hazen and Sawyer, Inc. NYC 208 Task 516/526, Volume II. Tables 1-7, 1-8, 1-12A, and 1-13.

3. Personal communication: Mr. William Pressman, Chief, Research and Development, New York City Department of Environmental Protection.

ROCHESTER, NEW YORK

Urban Characteristics

The drainage area in Rochester modeled by the 1978 Needs Survey is served entirely by combined sewers with an area of 11,476 acres (17.9 square miles) and a 1970 population of 200,000. Twenty-two percent of the combined sewer area is open space. Combined sewer overflow occurs approximately 75 times per year at 20 locations on the Genesee River. These overflow events cause violations of dissolved oxygen and fecal coliform standards. One secondary WWTP has a design capacity of 100 mgd and treats an average daily flow of 50 mgd which is discharged to Lake Ontario.

The average annual rainfall in Rochester is approximately 32.6 inches, from an average monthly low of 2.39 inches in February to a high of 3.09 inches in July, as shown in Figure B-3. Rainfall occurs for approximately 1,060 hours per year causing runoff for approximately 437 hours per year or 5% of the time. The mean annual flow and depth of the Genesee River are 2,743 cfs and 15 feet, respectively. Receiving water uses for the Genesee River are swimming and recreation and, for Lake Ontario, city water supply, swimming, fishing, boating, and recreation.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Rochester, New York, are shown in Figure B-3. Combined sewer overflow is a major source for the average annual load of SS, 57%. Storm runoff is a major source of Pb and SS average annual loads, 70% and 36%, respectively; and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 92%, 90%, and 55%, respectively.

Average annual loads in pounds per year from the area modeled by the 1978 Needs Survey are shown in Figure B-3. Combined sewer overflow is a major source of SS, 38%. Storm runoff average annual loads are zero since the entire basin modeled is served by combined sewers; and secondary WWTP effluent is a major source of TN, PO_4, Pb, BOD_5, and SS average annual loads, 99%, 91%, 84%, 77%, and 62%, respectively.

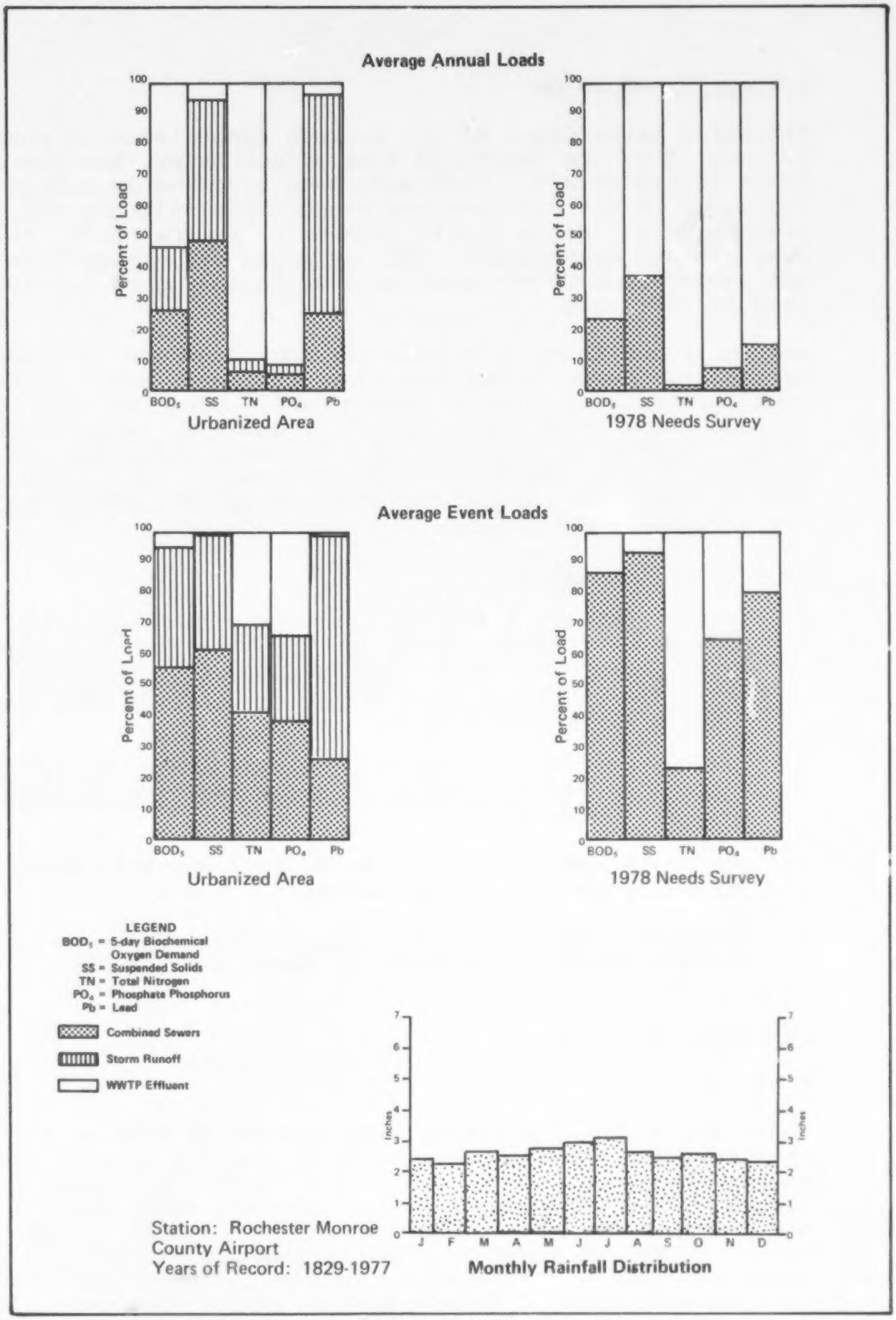


FIGURE B-3. Loading comparison for Rochester, New York.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Rochester, New York, are shown in Figure B-3. Combined sewer overflow is a major source of SS and BOD_5 average event loads, 61% and 57%, respectively. Storm runoff is a major source of Pb, SS, and BOB_5 average event loads, 73%, 39%, and 37%, respectively; and secondary WWTP effluent is a major source of the event load for PO_4, 36%.

Average event loads in pounds per hour from the area modeled by the 1978 Needs Survey are shown in Figure B-3. Combined sewer overflow is a major source of SS, BOD_5, Pb, and PO_4 average event loads, 93%, 86%, 80%, and 65%, respectively. Storm runoff average event loads are zero since the entire basin modeled is served by combined sewers; and secondary WWTP effluent is a major source of TN and PO_4 event loads, 77% and 35%, respectively.

Sources of Information

1. Edman, Anthony & Assoc., Lozier Engineering, Inc., and Seelye, Stevenson, Value and Knecht, Inc. Wastewater Facilities Plan, Combined Sewer Overflow Abatement Program, Rochester Pure Waters District, Monroe County, New York. December 1976.
2. New York State Department of Environmental Conservation. Water Quality Management Plan for the Genesee River Basin. November 1976.
3. Personal communication: N. G. Kaul New York Department of Environmental Conservation.
4. Personal communication: Jimmy Stewart Rochester Pure Waters District, Division of Sewer Maintenance.

SYRACUSE, NEW YORK

Urban Characteristics

The combined sewer drainage area modeled by O'Brien and Gere Engineers for the Syracuse 208 Study was 9,000 acres (14.1 square miles) out of a total 13,900 acres (21.7 square miles) with a 1970 population of 175,000. Less than 5% of the combined sewer drainage area of 9,000 acres is open space. Combined sewer overflow occurs approximately 170 times per year at 87 locations on the three streams flowing into Lake Onondaga. These overflow events eliminate all water contact sports in Onondaga Lake and cause combined sewer flooding into basements and streets. The only WWTP discharging to Lake Onondaga presently provides primary treatment to an average daily flow of 80 mgd at a design flow of 60 mgd. The present sewer system is in poor condition and is known to have a significant infiltration/inflow problem.

The average annual rainfall in Syracuse is 37.0 inches, ranging from an average monthly low of 2.68 inches in January to a high of 3.63 inches in June, as shown in Figure B-4. Rainfall occurs for approximately 1,244 hours per year, causing runoff for approximately 746 hours per year or 8.5% of the time. The mean residence time of Onondaga Lake is 150 to 200 days. Present receiving water uses include boating, picnicing, and non-water contact recreation.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Syracuse, New York, are shown in Figure B-4. Combined sewer overflow is a major source of SS, BOD_5, and Pb average annual loads, 66%, 37%, and 34%, respectively. Storm runoff is a major source of the average annual load of Pb, 62%, and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 89%, 87%, and 46%, respectively.

Average annual loads in pounds per year from the combined sewer drainage area modeled by the O'Brien and Gere 208 Study are shown in Figure B-4. Combined sewer overflow is a major source of the average annual load of SS, 52%. Storm runoff annual loads are zero since the entire basin modeled is served by combined sewers; and secondary WWTP effluent is a major source of TN, PO_4, BOD_5, Pb, and SS average annual loads, 99%, 95%, 86%, 83%, and 48%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Syracuse, New York, are shown in Figure B-4. Combined sewer overflow is a major source of SS, BOD_5, TN, PO_4, and Pb average event loads, 69%, 65%, 44%, 41%, and 35%, respectively. Storm runoff is a major source of the average event load for Pb, 64%; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 41% and 37%, respectively.

Average event loads in pounds per hour from the combined sewer drainage area modeled in the O'Brien and Gere 208 Study are shown in Figure B-4. Combined sewer overflow is a major source of SS, Pb, BOD_5, and PO_4 average event loads, 93%, 71%, 66%, and 40%, respectively. Storm runoff average event

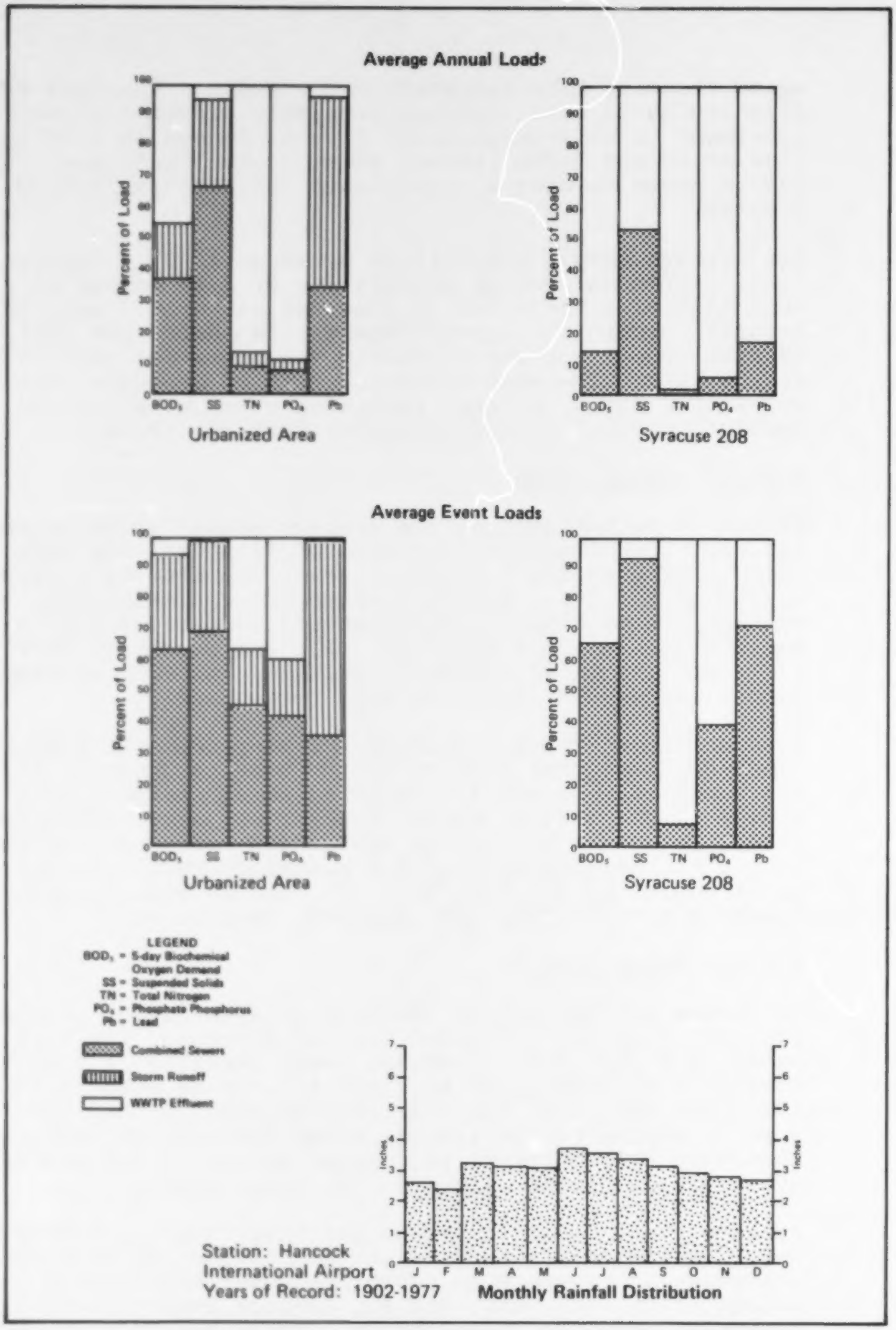


FIGURE B-4. Loading comparison for Syracuse, New York.

loads are zero since the entire basin modeled is served by combined sewers; and secondary WWTP effluent is a major source of TN, PO_4, and BOD_5 average event loads, 92%, 60%, and 34%, respectively.

Source of Information

1. Personal communication: Dwight A. MacArthur, O'Brien and Gere Engineers, Inc., Box 4873, Syracuse, New York 13221.

PHILADELPHIA, PENNSYLVANIA

Urban Characteristics

The drainage area modeled in Philadelphia by the 1978 Needs Survey is 110,000 acres (171.9 square miles) with a 1970 population of 2,076,900. The combined sewer drainage area of 50,000 acres (78.1 square miles) is essentially 100% developed. Combined sewer overflow occurs approximately 70 times per year at 176 locations on the Delaware River estuary. These overflow events restrict water contact recreation and cause extremely low dissolved oxygen concentrations in the receiving water. Three primary WWTP's treat an average daily flow of 714 mgd which is discharged to the Delaware River estuary. Industrial effluent is an important wastewater source from Philadelphia that is not included in this analysis.

The average annual rainfall in Philadelphia is approximately 41.2 inches, ranging from an average monthly low of 2.80 inches in October to a high of 4.52 inches in August, as shown in Figure B-5. Rainfall occurs for approximately 1,860 hours per year causing runoff for approximately 1,116 hours per year or 13% of the time. The mean annual flow and depth of the Delaware River estuary are 16,800 cfs and 21 feet, respectively. Present receiving water uses include water supply, navigation, fishing, and recreation.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Philadelphia, Pennsylvania, are shown in Figure B-5. Combined sewer overflow is a minor source of average annual loads for all parameters. Storm runoff is a major source of Pb and SS average annual loads, 93% and 80%, respectively; and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 94%, 93%, and 62%, respectively.

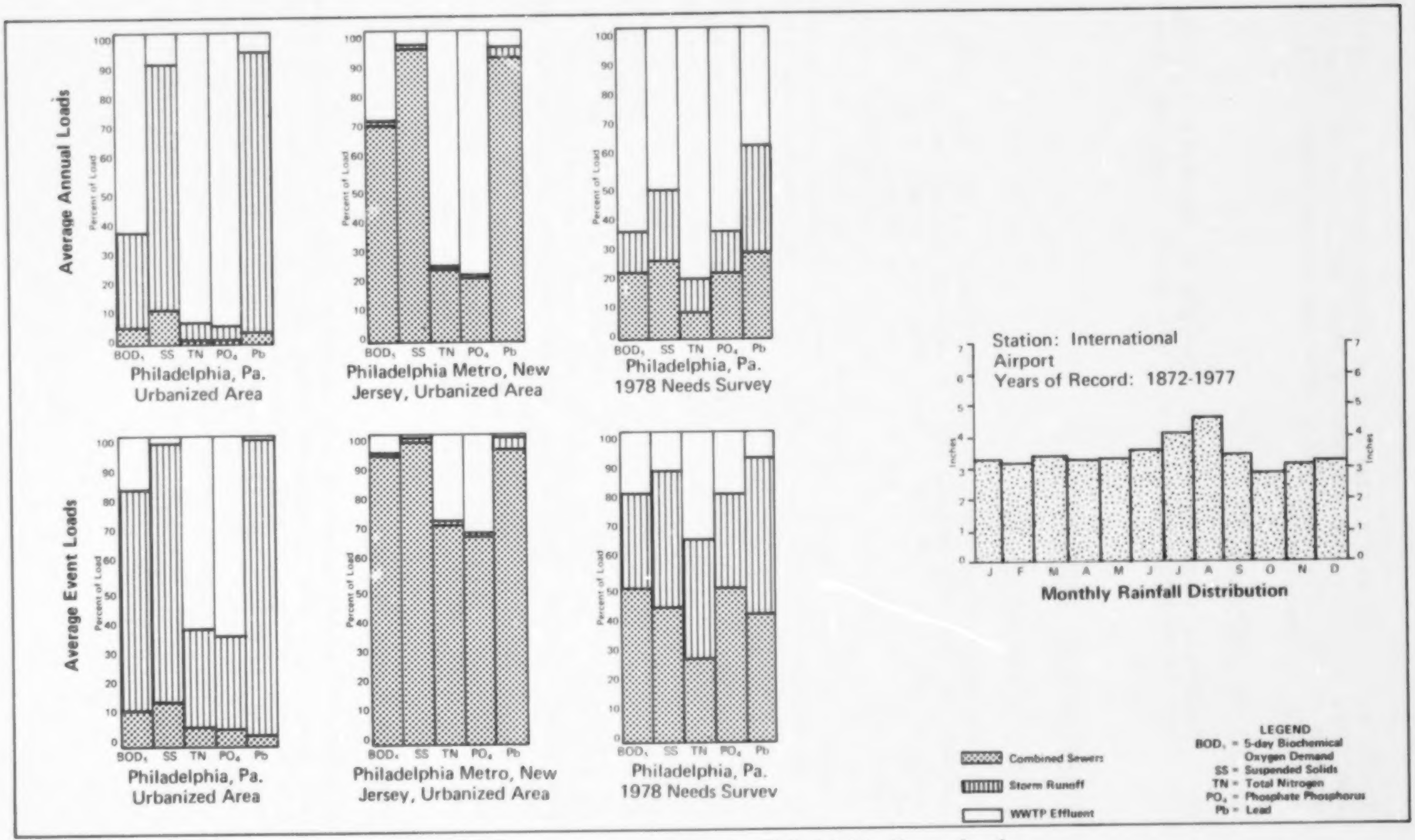


FIGURE B-5. Loading comparison for Philadelphia, Pennsylvania.

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Philadelphia Metro New Jersey are shown in Figure B-5. Combined sewer overflow is a major source of SS, Pb, and BOD_5 average annual loads, 97%, 94%, and 71%, respectively. Storm runoff is a minor source of average annual loads for all parameters; and secondary WWTP effluent is a major source of PO_4 and TN average annual loads, 79% and 76%, respectively.

Average annual loads in pounds per year from the area modeled by the 1978 Needs Survey are shown in Figure B-5. Combined sewer overflow is a minor source of average annual loads for all parameters. Storm runoff is a major source of the average annual load for Pb, 33%, and secondary WWTP effluent is a major source of TN, PO_4, BOD_5, SS, and Pb average annual loads, 81%, 65%, 65%, 49%, and 39%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Philadelphia, Pennsylvania, are shown in Figure B-5. Combined sewer overflow is a minor source of average event loads for all parameters. Storm runoff is a major source of Pb, SS, BOD_5, and TN average event loads, 96%, 86%, 72%, and 33%, respectively; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 66% and 62%, respectively.

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Philadelphia Metro New Jersey are shown in Figure B-5. Combined sewer overflow is a major source of SS, Pb, BOD_5, TN, and PO_4 event loads, 99%, 97%, 95%, 71%, and 67%, respectively. Storm runoff and secondary WWTP effluent are minor sources of the average event loads for all parameters.

Average event loads in pounds per hour from the area modeled in the 1978 Needs Survey are shown in Figure B-5. Combined sewer overflow is a major source of BOD_5, PO_4, SS, and Pb average event loads, 51%, 51%, 46%, and 42%, respectively. Storm runoff is a major source of Pb, SS, and TN average event loads, 50%, 43%, and 37%, respectively; and secondary WWTP effluent is a major source of the average event load for TN, 36%.

Sources of Information

1. Urban Stormwater Quality/Land Use Characterization, prepared by Philadelphia Water Department Research and Development Division. November 1977.

2. Facility Plan, City of Philadelphia, Combined Sewer Overflow Control, by Watermation, Inc., July 1976.

3. Thomann, R. V., Systems Analysis and Water Quality Management, Environmental Research and Applications, Inc. (now McGraw-Hill), 1972.

4. Personal communication: Dennis Blair, Philadelphia Water Department.

WASHINGTON, D.C.

Urban Characteristics

The drainage area modeled by the 1978 Needs Survey for Washington, D.C., is 202,521 acres (316.4 square miles) with a 1970 population of 4,000,000. The combined sewer drainage area of 12,396 acres (19.4 square miles) is essentially 100% developed. Combined sewer overflow occurs approximately 55 times per year at five locations on the Potomac River estuary. These overflow events result in the elimination of water contact recreation and commercial fishing in the receiving water. Six secondary WWTP's have a design capacity of 415 mgd and treat an average daily flow of 361 mgd which is discharged to the Potomac River estuary.

The average annual rainfall in Washington, D.C., is approximately 39.9 inches, ranging from an average monthly low of 2.52 inches in February to a high of 4.68 inches in August, as shown in Figure B-6. Rainfall occurs for approximately 1,050 hours per year, causing runoff for approximately 630 hours per year or 7% of the time. The mean annual flow and depth of the Potomac River estuary are 10,000 cfs and 15 feet, respectively. Receiving water uses include navigation, sport fishing, and non-water contact recreation.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Washington, D.C., are shown in Figure B-6. Combined sewer overflow is a major source of SS and Pb average annual loads, 68% and 36%, respectively. Storm runoff is a major source of the average annual load for Pb, 58%; and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 93%, 92%, and 57%, respectively.

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Washington, D.C. Metro Virginia are shown in Figure B-6. Combined sewer overflow

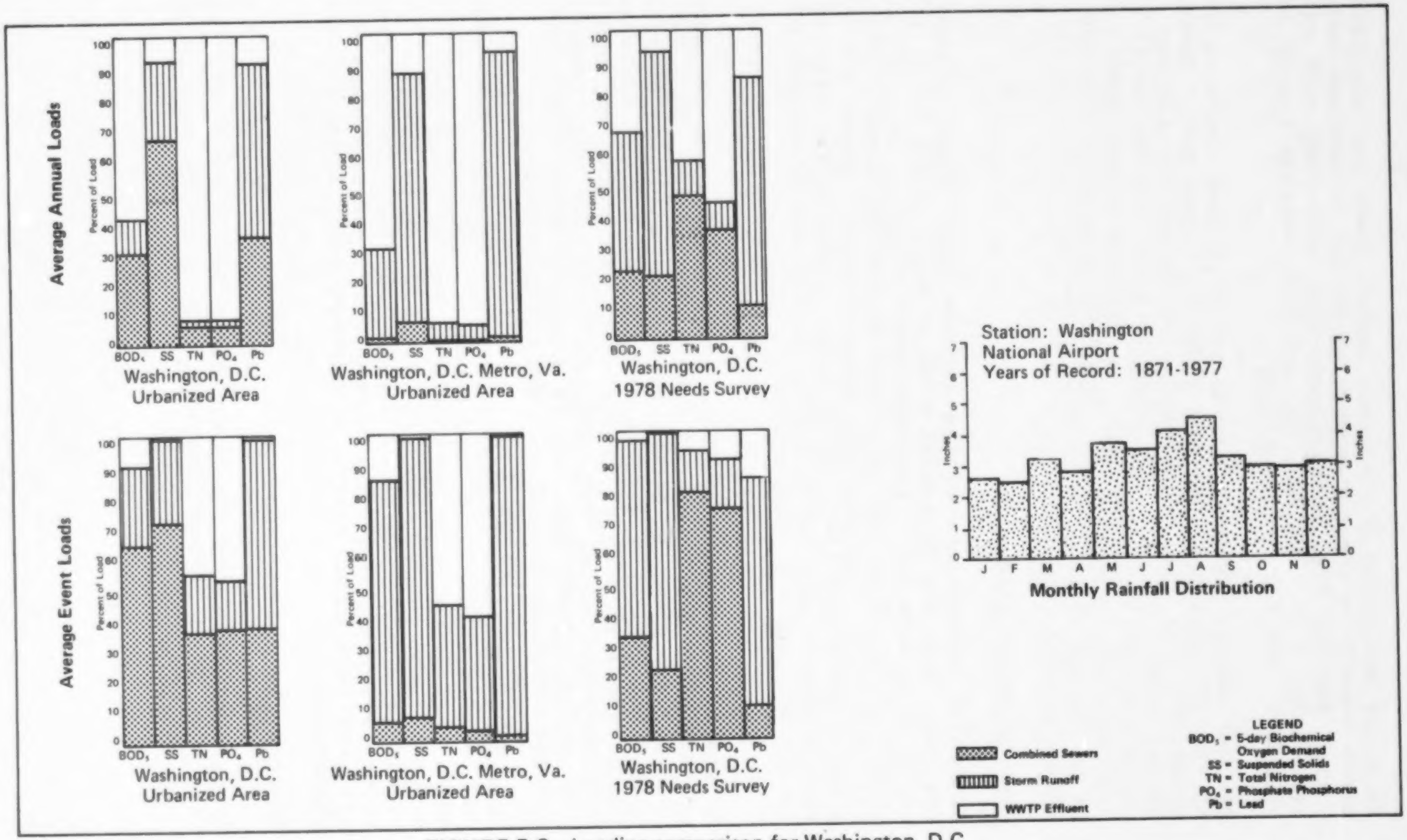


FIGURE B-6. Loading comparison for Washington, D.C.

is minor source of the average annual loads for all parameters. Storm runoff is a major source of Pb and SS average annual loads, 94% and 83%, respectively; and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 95%, 94%, and 68%, respectively.

Average annual loads in pounds per year from the area modeled by the 1978 Needs Survey are shown in Figure B-6. Combined sewer overflow is a major source of TN and PO_4 average annual loads, 48% and 38%, respectively. Storm runoff is a major source of Pb, SS, and BOD_5 average annual loads, 76%, 74%, and 44%, respectively, and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 55%, 44%, and 33%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Washington, D.C., are shown in Figure B-6. Combined sewer overflow is a major source of SS, BOD_5, PB, PO_4, and TN average event loads, 73%, 66%, 38%, 38%, and 37%, respectively. Storm runoff is a major source of the average event load for Pb, 61%; and WWTP effluent is a major source of PO_4 and TN average event loads, 47% and 46%, respectively.

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Washington, D.C. Metro Virginia are shown in Figure B-6. Combined sewer overflow is a minor source of average event loads for all parameters. Storm runoff is a major source of Pb, SS, BOD_5, TN, and PO_4 average event loads, 98%, 92%, 81%, 42%, and 38%, respectively; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 59% and 55%, respectively.

Average event loads in pounds per hour from the area modeled in the 1978 Needs Survey are shown in Figure B-6. Combined sewer overflow is a major source of TN, PO_4, and BOD_5 average event loads, 81%, 77%, and 33%, respectively. Storm runoff is a major source of SS, Pb, and BOD_5 average event loads, 77%, 76%, and 64%, respectively; and secondary WWTP effluent is a minor source of average event loads for all parameters.

Sources of Information.

1. Water Resources Planning Board, Metropolitan Washington, COG, Major Sewage Treatment Plants in the Washington Metropolitan Area. 1976.

2. Ibid, The National Pollutant Discharge Elimination System. April 28, 1977.

3. Personal communication: Ed Jones, Operator, Blue Plains WWTP, Washington, D.C.

4. Personal communication: Ken Sujishiro, Metropolitan Washington Council of Governments.

ATLANTA, GEORGIA

Urban Characteristics

The drainage area modeled in the 1978 Needs Survey for Atlanta is the 149,860 acres (234.2 square miles) tributary to the Chattahoochee River with a 1970 population of 780,000. The combined sewer drainage area of 9,060 acres (14.2 square miles) within this basin is essentially 100% developed. Combined sewer overflow occurs approximately 90 times per year at six locations on the Chattahoochee River. These overflow events together with stormwater runoff cause the dissolved oxygen concentration to fall below 2 mg/l several times each year. Five secondary WWTP's treat an average daily flow of 120 mgd which is discharged to the Chattahoochee River.

The average annual rainfall in Atlanta is approximately 48.6 inches, from a monthly low of 2.59 inches in October to a high of 5.63 inches in March, as shown in Figure B-7. Rainfall occurs for approximately 930 hours causing runoff for approximately 667 hours per year or 7.6% of the time. The mean annual flow and depth of the Chatahoochee River are 2,742 cfs and 6.5 feet, respectively. Present receiving water uses include recreation and sport fishing.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Atlanta, Georgia, are shown in Figure B-7. Combined sewer overflow is a minor source of average annual loads for all parameters. Storm runoff is a major source of Pb, SS, and BOD_5 average annual loads 90%, 71%, and 37%, respectively; and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads 91%, 89%, and 51%, respectively.

Average annual loads in pounds per year from the area modeled by the 1978 Needs Survey are shown in Figure B-7. Combined sewer overflow is a major source of the average annual load for Pb, 44%. Storm runoff is a major source of the SS, Pb,

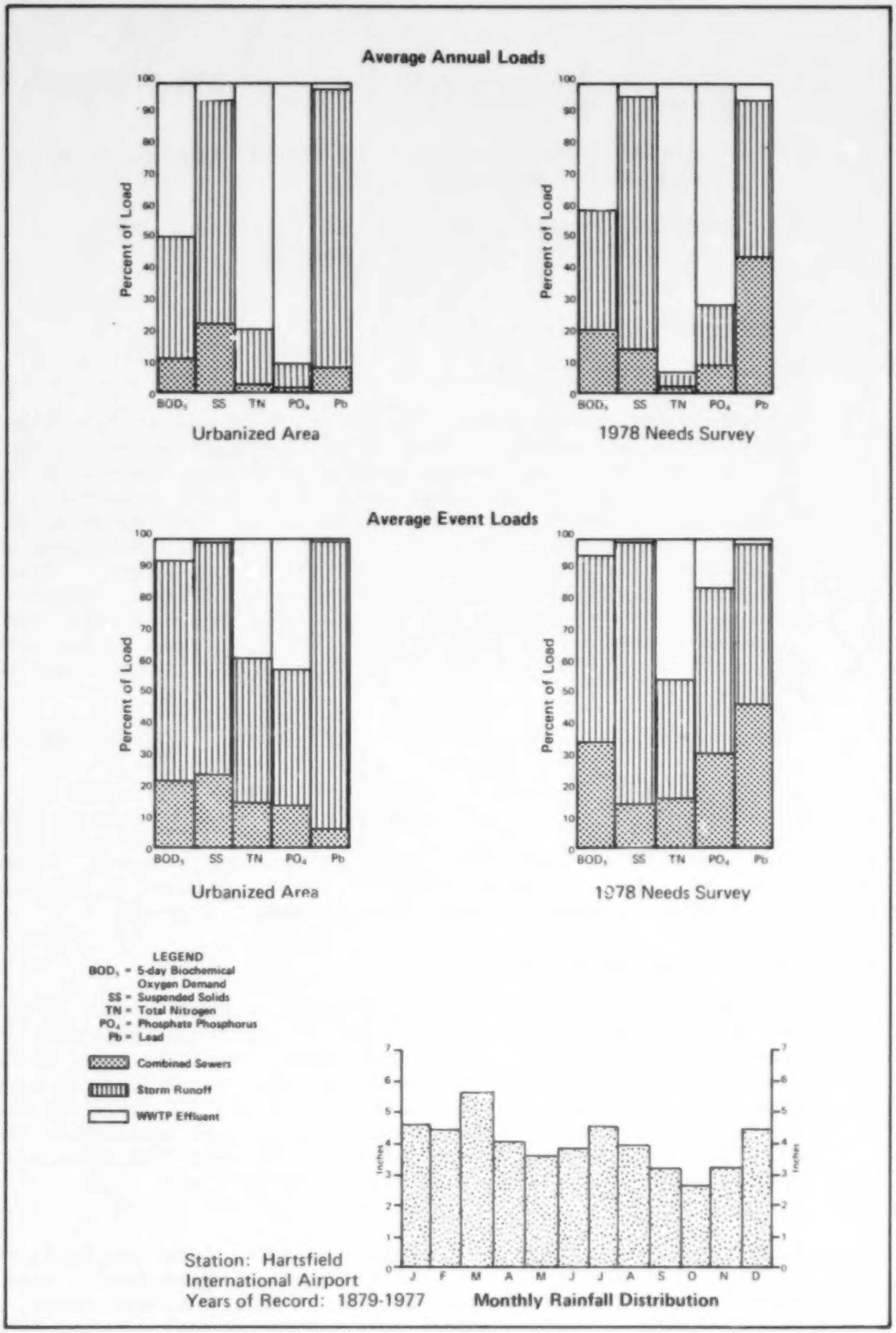


FIGURE B-7. Loading comparison for Atlanta, Georgia.

and BOD_5 average annual loads, 81%, 51%, and 36%, respectively; and secondary WWTP effluent is a major source of TN, PO_4, and BOD_5 average annual loads, 92%, 72%, and 43%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Atlanta, Georgia, are shown in Figure B-7. Combined sewer overflow is a minor source of average event loads for all parameters. Storm runoff is a major source of Pb, SS, BOD_5, TN, and PO_4 average event loads, 93%, 75%, 70%, 46%, and 43%, respectively; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 43% and 39%, respectively.

Average event loads in pounds per hour from the area modeled in the 1978 Needs Survey are shown in Figure B-7. Combined sewer overflow is a major source of Pb and BOD_5 average event loads, 47% and 34%, respectively. Storm runoff is a major source of SS, BOD_5, PO_4, Pb, and TN average event loads, 85%, 61%, 54%, 53%, and 36%, respectively; and secondary WWTP effluent is a major source for the average event load of TN, 47%.

Sources of Information

1. Black, Crow and Eidsness, Inc., and Jordan, Jones, and Goulding, Inc. Nonpoint Pollution Evaluation, Atlanta Urban Area. May 1975.

2. Black, Crow and Eidsness, Inc. Storm and Combined Sewer Pollution Sources and Abatement, Atlanta, Georgia. January 1971.

3. Personal communication: Phil Nungasser, City of Atlanta Bureau of Pollution Control.

CHICAGO, ILLINOIS

Urban Characteristics

The Metropolitan Sanitary District of Greater Chicago (MSDGC) serves a total area of 555,000 acres (867.2 square miles) with a combined sewer drainage area of 240,000 acres (375 square miles) and a 1970 population of 5,500,000. The district is approximately 15% open space. Combined sewer overflow occurs approximately 100 times per year at 645 locations on the Chicago River, Calumet River, and the sanitary and ship canal system. The ship canal system was built during the 1890's to divert Chicago wastewaters away from Lake Michigan, the source of drinking water for Chicago, to the Illinois River. In addition to low dissolved oxygen concentrations and significant benthal deposits in the receiving waters, these overflow events cause a potential public health hazard by flooding basements, streets, and Lake Michigan (19 Lake Michigan floods have occurred since 1954). The MSDGC has seven WWTP's. Three provide secondary treatment to a design flow of 1,753 mgd and four provide tertiary treatment to a design flow of 40 mgd. A tunnel and reservoir plan known as the TARP project has been designed by MSDGC to capture and store most combined sewer overflow for subsequent secondary treatment.

The average annual rainfall in Chicago is 33.6 inches, from an average monthly low of 1.80 inches in February to a high of 3.47 inches in June, as shown in Figure B-8. Rainfall occurs for approximately 1,529 hours per year causing runoff for approximately 917 hours per year or 10.5% of the time. The mean annual flows of the Chicago North Branch, Grand Calument, and Little Calumet Rivers are 117 cfs, 211 cfs, and 240 cfs, respectively. Receiving water uses include navigation, public water supply, swimming, fishing, and other recreational activities.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Chicago are shown in Figure B-8. Combined sewer overflow is a major source of SS, Pb, and BOD_5 average annual loads, 77%, 48%, and 41%, respectively. Storm runoff is a major source of the average annual load for Pb, 48%; and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 90%, 89%, and 49%, respectively.

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Chicago Metro Indiana are shown in Figure B-8. Combined sewer overflow is a major source of SS and BOD_5 average annual loads, 63% and 33%, respectively. Storm runoff is a major source of the average annual load for Pb, 65%; and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 91%, 88%, and 50%, respectively.

Average annual loads in pounds per year from the area modeled by the MSDGC facilities plan are shown in Figure B-8. Combined sewer overflow is a major source of BOD_5 and SS average annual loads, 54% and 36%, respectively. No estimates of the storm runoff average annual loads were made. Existing WWTP effluent is a major source of TN, PO_4, Pb, SS, and BOD_5 average annual loads, 95%, 92%, 76%, 64%, and 46%, respectively.

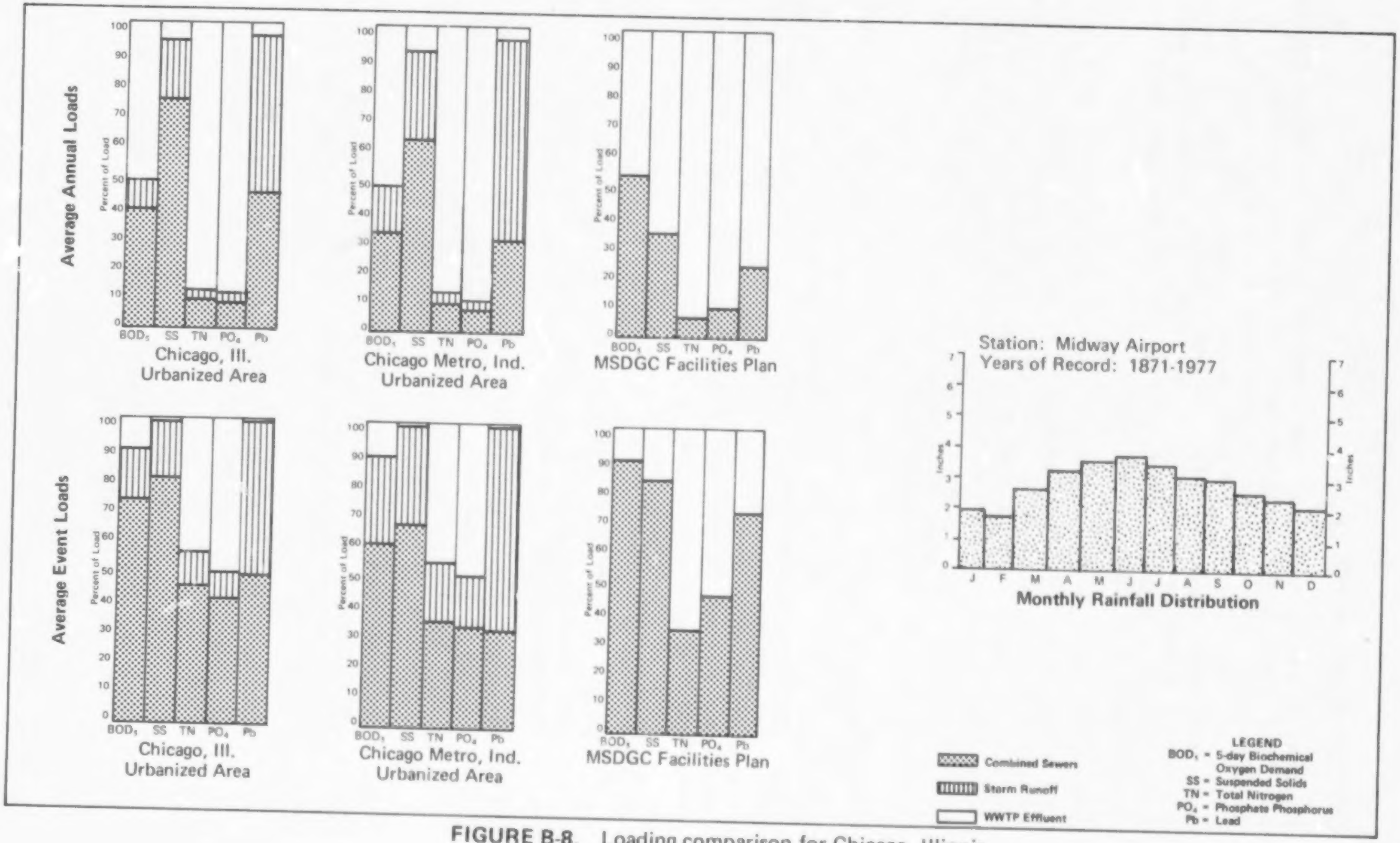


FIGURE B-8. Loading comparison for Chicago, Illinois.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Chicago are shown in Figure B-8. Combined sewer overflow is a major souce of SS, BOD_5, Pb, TN, and PO_4 average event loads, 81%, 73%, 50%, 45%, and 42%, respectively. Storm runoff is a major source of the average event load for Pb, 50%; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 49% and 44%, respectively.

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Chicago Metro Indiana are shown in Figure B-8. Combined sewer overflow is a major source of SS, BOD_5, TN and PO_4 average event loads, 67%, 60%, 37%, and 34%, respectively. Storm runoff is a major source of the average event load for Pb, 67%; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 50% and 45%, respectively.

Average event loads in pounds per hour from the area modeled in the MSDGC facilities plan are shown in Figure B-8. Combined sewer overflow is a major source of BOD_5, SS, Pb, PO_4, and TN average event loads, 92%, 84%, 75%, 47%, and 35%, respectively. No estimates of the storm runoff average event loads were made. The existing WWTP effluent is a major source of TN and PO_4 average event loads, 65% and 53%, respectively.

Sources of Information.

1. Dale, J. R., Jr. Bottling Rainstorms--Chicago's Tunnel and Reservoir Plan. J. Wat. Poll. Cont. Fed Monitor. Volume 50, No. 8. August 1978. pp. 1888-1892.

2. General Accounting Office, Comptroller General Report to the U.S. Congress. Metropolitan Chicago's Combined Water Cleanup and Flood Control Program: Status and Problems. No. PSAD-78-94. May 24, 1978.

3. Metropolitan Sanitary District of Greater Chicago. Development of a Flood and Pollution Control Plan for the Chicagoland Area, Summary of Technical Reports. August 1972.

4. Metropolitan Sanitary District of Greater Chicago. Facilities Planning Study MSDGC Update Supplement and Summary. May 1977.

5. Personal communication: J. H. Irons, Supervising Civil Engineer Tunnel and Reservoir Section, Metro. Sanitary District of Greater Chicago (MSDGC).

DETROIT, MICHIGAN

Urban Characteristics

The Detroit Water and Sewerage Department (DWSD) serves 71 municipalities with a total drainage area of 312,692 acres (488.6 square miles), a combined sewer drainage area of 154,700 acres (241.7 square miles), and a 1970 population of 2,982,000. A segmented facilities plan for the DWSD modeled a combined sewer drainage area of 92,392 acres (144.4 square miles) which is 95% developed and has an average population density of 15.3 people per acre. Combined sewer overflow is controlled by a remote monitoring system which utilizes in-line storage to reduce the number of overflow events to approximately 15 per year at 77 locations on the Rouge and Detroit Rivers. These overflow events cause benthal sludge deposits and occasional low dissolved oxygen concentrations in the Rouge River. One WWTP provides a design capacity of 1,200 mgd primary and 600 mgd secondary and treats an average daily flow of 650 mgd.

The average annual rainfall in Detroit is 31.5 inches, ranging from an average monthly low of 2.05 inches in February to a high of 3.32 inches in June, as shown in Figure B-9. Rainfall occurs for approximately 515 hours per year, causing runoff for approximately 309 hours per year and combined sewer overflow for approximately 113 hours per year of 1.29% of the time. The mean annual flows and depths of the Detroit and Rouge Rivers are 190,800 cfs and 27 feet and 270 cfs and 15 feet, respectively. Present uses of the Detroit River include water supply, cold water fishing, total body contact recreation, and transportation. Present receiving water uses of the Rouge River include industrial water supply, limited body contact recreation, warm water fishing, and transportation.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Detroit, Michigan, are shown in Figure B-9. Combined sewer overflow is a major source of SS, Pb, and BOD_5 average annual loads, 75%, 45%, and 40%, respectively. Storm runoff is a major source of the average annual load for Pb, 50%; and WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 90%, 88%, and 49%, respectively.

Average event loads in pounds per hour from the area modeled in the DWSD segmented facilities plan are shown in Figure B-9. Combined sewer overflow is a major source of Pb and SS average event loads, 60% and 46%, respectively. Storm runoff is a minor source of annual loads for all parameters,

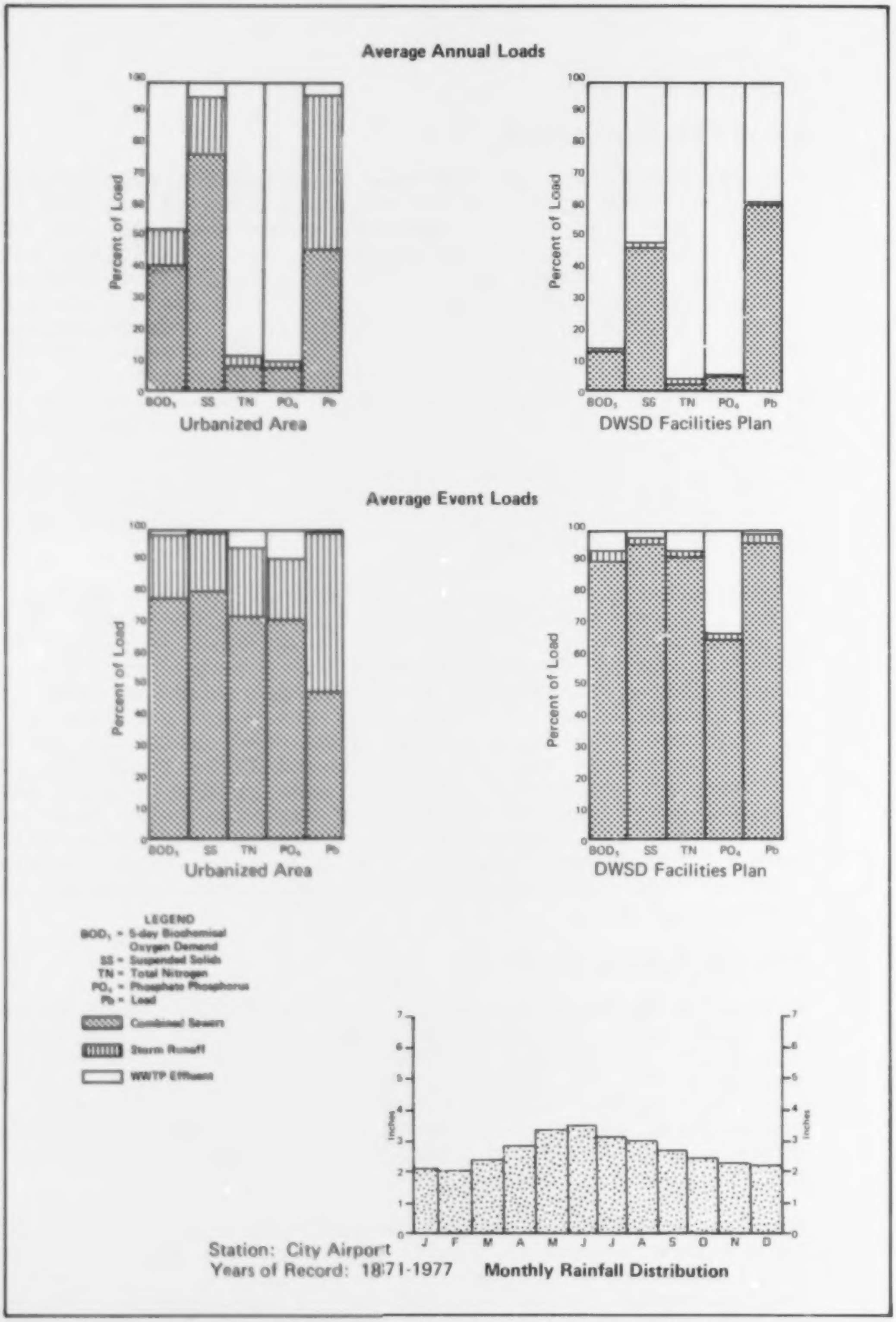


FIGURE B-9. Loading comparison for Detroit, Michigan.

and WWTP effluent is a major source of TN, PO_4, BOD_5, SS, and Pb average annual loads, 98%, 98%, 87%, 53%, and 39%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Detroit, Michigan, are shown in Figure B-9. Combined sewer overflow is a major source of SS, BOD_5, TN, PO_4, and Pb average event loads, 79%, 78%, 72%, 71%, and 47%, respectively. Storm runoff is a major source of the average event load for Pb, 53%; and secondary WWTP effluent is a minor source of event loads for all parameters.

Average event loads in pounds per hour from the remote controlled combined sewer area modeled in the DWSD segmented facilities plan are shown in Figure B-9. Combined sewer overflow is a major source of Pb, SS, TN, BOD_5, and PO_4 average event loads, 98%, 95%, 91%, 89%, and 63%, respectively. Storm runoff and WWTP effluent are minor sources of average event loads for all parameters.

Sources of Information

1. Watt, T. R., Skrentner, R. G., and Davanzo, A. C. Sewerage System Monitoring and Remote Control. EPA-670/2-75-020. May 1975.

2. Giffels/Black & Veatch. Detroit Water and Sewerage District (DWSD) Segmented Facilities Plan. June 1977.

3. Personal communication: D. G. Suhre, General Superintendent of Engineering, Detroit Water and Sewerage Department.

MILWAUKEE, WISCONSIN

Urban Characteristics

The drainage area modeled for Milwaukee by the 1978 Needs Survey was 33,200 acres (51.9 square miles) tributary to the Milwaukee River with a 1970 population of 441,800. The combined sewer drainage area of 5,800 acres (9.1 square miles) is essentially 100% developed. Combined sewer overflow occurs approximately 60 times per year at 62 locations on the Milwaukee River. These overflow events cause the resuspension of accumulated sediment deposits which can cause the dissolved oxygen concentration to reach zero for several hours and kill many fish. The Jones Island WWTP has a design capacity of 200 mgd and treats an average daily flow of 137 mgd which is discharged to Lake Michigan.

The average annual rainfall in Milwaukee is approximately 30.3 inches, ranging from an average monthly low of 1.57 inches in February to a high of 3.53 inches in June, as shown in Figure B-10. Rainfall occurs for approximately 926 hours per year, causing runoff for approximately 673 hours per year or 7.7% of the time. The mean annual flow and depth of the Milwaukee River are 381 cfs and 6 feet, respectively. Present receiving water uses include industrial water supply, fish survival, swimming, and recreation.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Milwaukee, Wisconsin, are shown in Figure B-10. Combined sewer overflow is a major source of the average annual load for SS, 41%. Storm runoff is a major source of Pb and SS average annual loads, 81% and 51%, respectively; and secondary WWTP effluent is a major source of TN, PO_4, and BOD_5 average annual loads, 93%, 93%, and 60%, respectively.

Average annual loads in pounds per year from the Milwaukee River watershed area modeled by the 1978 Needs Survey are shown in Figure B-10. Combined sewer overflow is a major source of the average annual load for Pb, 60%. Storm runoff is a major source of the average annual load for SS only, 36%; and secondary WWTP effluent is a major source of TN, PO_4, BOD_5, and SS average annual loads, 98%, 94%, 84%, and 46%, respectively. It should be noted, however, that the WWTP effluent is discharged directly to Lake Michigan and not to the Milwaukee River.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Milwaukee, Wisconsin are shown in Figure B-10. Combined sewer overflow is a major source of SS and BOD_5 average event loads, 44% and 38% respectively. Storm runoff is a major source of Pb, SS, and BOD_5 average event loads, 84%, 55%, and 51%, respectively; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 52% and 48%, respectively.

Average event loads in pounds per hour from the Milwaukee River watershed area modeled in the 1978 Needs Survey are shown in Figure B-10. Combined sewer overflow is a major source of Pb and BOD_5 average event loads, 74% and 54%, respectively. Storm runoff is a major source of the average event load for SS, 63%; and secondary WWTP is a major source of TN, and PO_4 average event loads, 80%, and 56%, respectively.

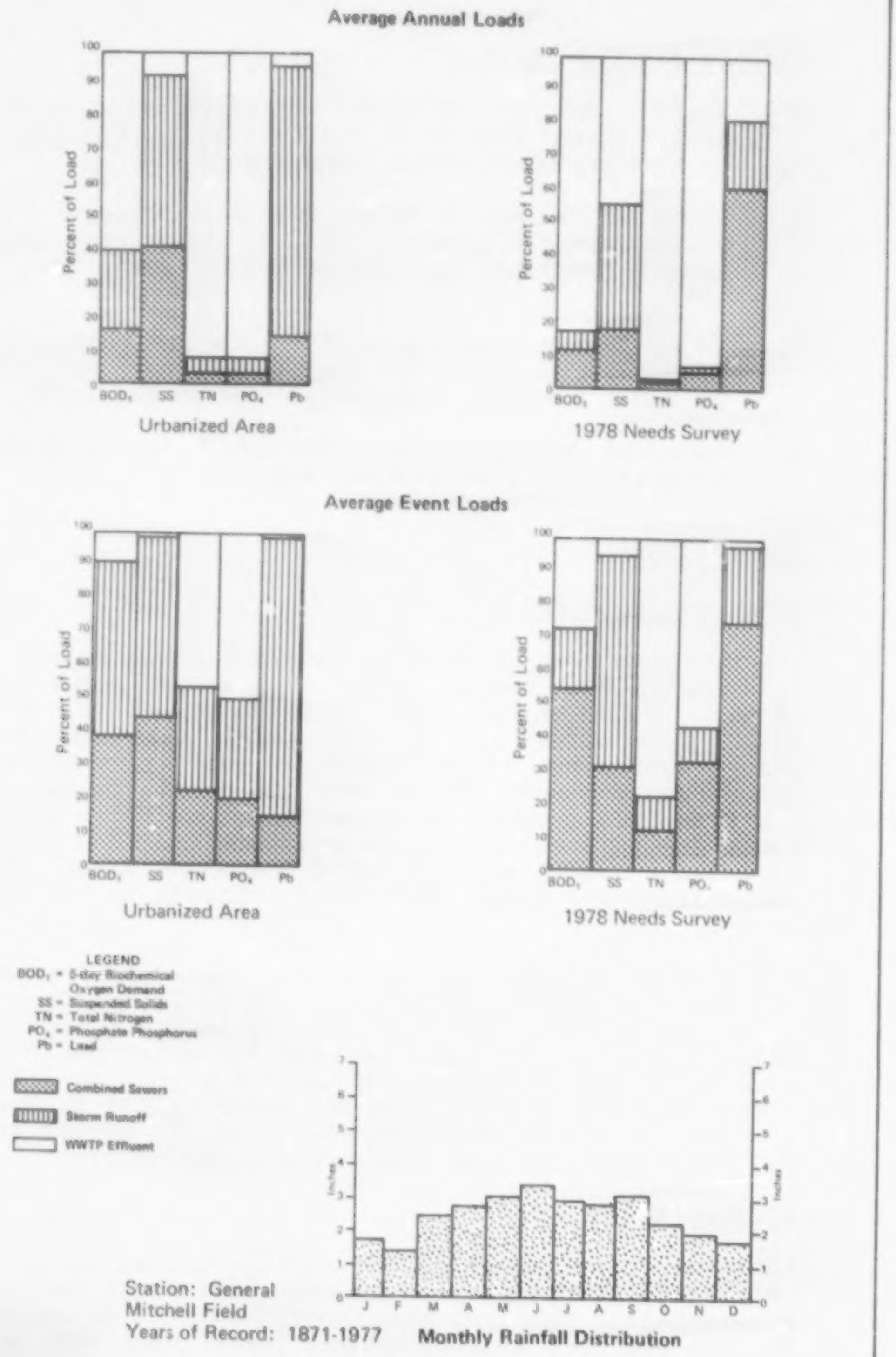


FIGURE B-10. Loading comparison for Milwaukee, Wisconson.

Sources for Information

1. State of the Art of Water Pollution Control in Southeastern Wisconsin, Vol. 1, Point Sources, Prepared by Stanley Consultants, Inc. July 1977.

2. State of the Art of Water Pollution Control in Southeastern Wisconsin, Vol. 3, Urban Storm-Water Runoff, Prepared by Stanley Consultants, Inc. July 1977.

3. Water Quality and Flow of Streams in Southeastern Wisconsin, prepared by the Southeastern Wisconsin Regional Planning Commission. November 1966.

4. Personal communication: William A. Kneutzberger, Envirex, Inc., Milwaukee, Wisconsin.

BUCYRUS, OHIO

Urban Characteristics

The drainage area modeled by the 1978 Needs Survey is 2,599 acres (4.1 square miles) with a 1970 population of 13,111. The combined sewer drainage area of 2,000 acres (3.1 square miles) is 15% open space. Combined sewer overflow occurs approximately 140 times per year at 24 locations on the Sandusky River. These overflow events cause consistently low dissolved oxygen concentrations that often go to zero at night due to accumulated sludge deposits. One secondary WWTP has a design capacity of 4.2 mgd and treats an average daily flow of 2.6 mgd which is discharged to the Sandusky River.

The average annual rainfall in Bucyrus is 33.6 inches, ranging from an average monthly low of 1.73 inches in October to a high of 3.70 inches in May, as shown in Figure B-11. Rainfall occurs for approximately 930 hours per year causing runoff for approximately 548 hours per year or 6.3% of the time. The mean annual flow and depth of the Sandusky River are 108 cfs and 1 foot, respectively. Receiving water uses include recreation and downstream water supply.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the City of Bucyrus, Ohio, are shown in Figure B-11. Combined sewer overflow is a major source of SS, Pb, and BOD_5 average annual loads, 94%, 80%, and 71%, respectively. Storm runoff is a minor source of average annual loads for all parameters; and secondary WWTP effluent

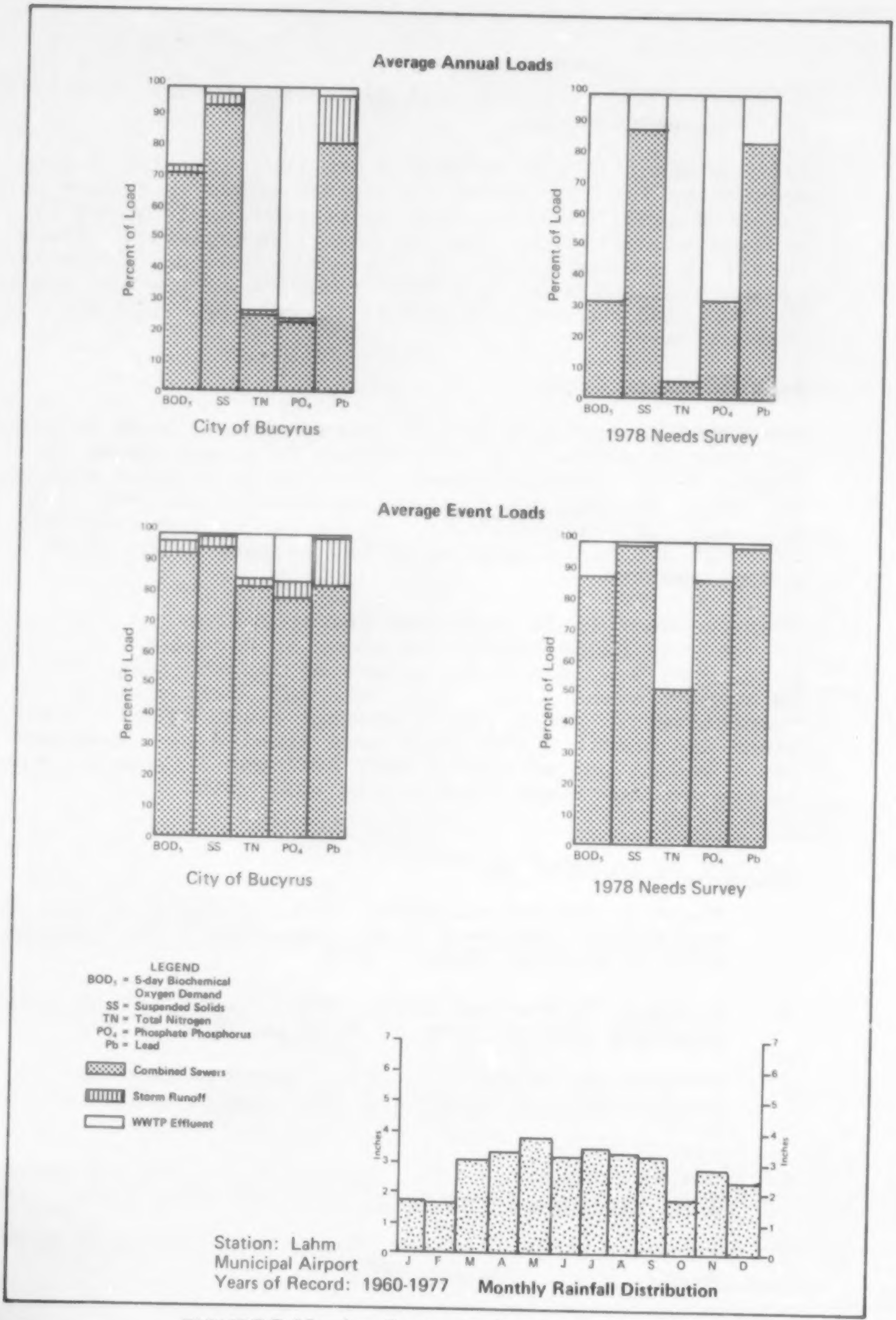


FIGURE B-11. Loading comparison for Bucyrus, Ohio.

is a major source of PO_4 and TN average annual loads, 77% and 74%, respectively.

Average annual loads in pounds per year from the area modeled by the 1978 Needs Survey are shown in Figure B-11. Combined sewer overflow is a major source of SS and Pb average annual loads, 88% and 83%, respectively. Storm runoff is a minor source of the average annual loads for all parameters; and secondary WWTP effluent is a major source of TN, BOD_5 and PO_4 average annual loads, 94%, 70%, and 69%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the City of Bucyrus, Ohio, are shown in Figure B-11. Combined sewer overflow is a major source of SS, BOD_5, Pb, TN, and PO_4 average event loads 96%, 93%, 83%, 81%, and 79%, respectively. Storm runoff and secondary WWTP effluent are minor sources of the average event loads for all parameters.

Average event loads in pounds per hour from the area modeled in the 1978 Needs Survey are shown in Figure B-11. Combined sewer overflow is a major source of SS, Pb, BOD_5, PO_4, and TN average event loads, 99%, 99%, 88%, 88%, and 51%, respectively. Storm runoff average event loads are zero since the entire 2,599 acres were modeled as a combined sewer basin, and secondary WWTP effluent is a major source of the average event load for TN only, 49%.

Sources of Information

1. Floyd G. Browne and Assoc. Ltd. Facilities Plan for Wastewater Treatment Plant Improvement and Appurtenances. City of Bucyrus, Ohio. 1976.

2. Floyd G. Browne and Assoc. Ltd. Infiltration/Inflow Analysis Report, City of Bucyrus, Ohio. 1974.

3. Burgess and Niple Ltd. Final Report, Land Use, Transportation, Parks and Open Space. Columbus, Ohio. 1974.

4. Burgess and Niple Ltd. Stream Pollution and Abatement from Combined Sewer Overflow. Columbus, Ohio. 1969.

5. Personal communication: Garry Cole, Floyd G. Browne & Assoc. Ltd., Marion, Ohio.

DES MOINES, IOWA

Urban Characteristics

The drainage area modeled in Des Moines by the 1978 Needs Survey was 49,018 acres (76.6 square miles) with a 1970 population of 255,000. The combined sewer drainage area of 4,018 acres (6.3 square miles) is essentially 100% developed. Combined sewer overflow occurs approximately 105 times per year at eight locations on the Des Moines River. These overflow events together with the urban stormwater runoff cause low dissolved oxygen concentrations during the summer months. One secondary WWTP has a design capacity of 35 mgd and treats an average daily flow of 39 mgd which is discharged to the Des Moines River.

The average annual rainfall in Des Moines is approximately 31.5 inches, ranging from an average monthly low of 1.12 inches in January to a high of 4.66 inches in June, as shown in Figure B-12. Rainfall occurs for approximately 630 hours per year, causing runoff for approximately 367 hours per year or 4.2% of the time. The mean annual flow and depth of the Des Moines River are 4,280 cfs and 5.8 feet, respectively. Present receiving water uses include fishing, recreation, and upstream water supply (Raccoon River).

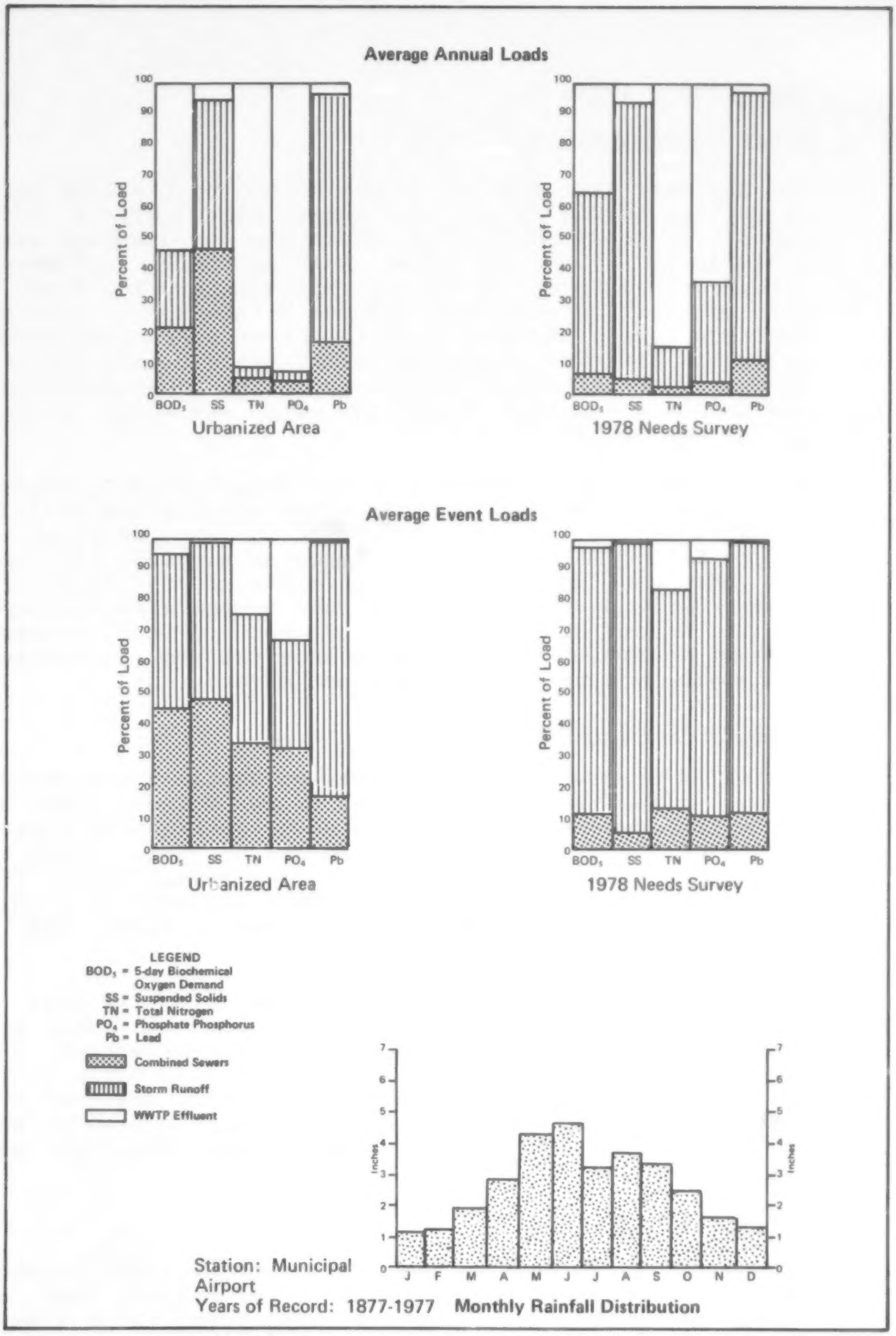
Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Des Moines, Iowa, are shown in Figure B-12. Combined sewer overflow is a major source of the average annual load for SS, 46%. Storm runoff is a major source of Pb and SS average annual loads, 79% and 48%, respectively; and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 92%, 91%, and 55%, respectively.

Average annual loads in pounds per year from the area modeled by the 1978 Needs Survey are shown in Figure B-12. Combined sewer overflow is a minor source of average annual loads for all parameters. Storm runoff is a major source of SS, Pb, and BOD_5 average annual loads, 87%, 86%, and 57%, respectively; and secondary WWTP effluent is a major source of TN, PO_4, and BOD_5 average annual loads, 84%, 64%, and 36%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Des Moines, Iowa, are shown in Figure B-12. Combined sewer overflow is a major source of SS, BOD_5, and TN average event loads, 49%, 45%,



Average Annual Loads

Average Event Loads

Station: Municipal Airport
Years of Record: 1877-1977

Monthly Rainfall Distribution

FIGURE B-12. Loading comparison for Des Moines, Iowa.

and 33%, respectively. Storm runoff is a major source of Pb, SS, BOD_5, TN, and PO_4 average event loads, 82%, 51%, 50%, 37%, and 35%, respectively; and secondary WWTP effluent is a major source of PO_4 average event loads, 33%.

Average event loads in pounds per hour from the area modeled by the 1978 Needs Survey are shown in Figure B-12. Combined sewer overflow is a minor source of average event loads for all parameters. Storm runoff is a major source of SS, Pb, BOD_5, PO_4, and TN average event loads, 93%, 88%, 86%, 82%, and 68%, respectively; and secondary WWTP effluent is a minor source of average event loads for all parameters.

Sources of Information

1. Henningson, Durham & Richardson. Combined Sewer Overflow Abatement Plan, Des Moines, Iowa. EPA R2-73-170. April 1974.
2. Iowa Department of Environmental Quality. Iowa Water Quality Management Plan, Des Moines River Basin. Draft. July 1975.
3. Personal communication: Mr. Leadington, Iowa Department of Environmental Quality, Des Moines, Iowa.

SAN FRANCISCO, CALIFORNIA

Urban Characteristics

The City of San Francisco is served completely by combined sewers with a combined sewer drainage area of 24,637 acres (38.5 square miles) and a 1970 population of 712,000. Except for parks, military reservations, and mountain slopes, the area is 100% developed. Combined sewer overflow occurs at 39 locations on San Francisco Bay to the east and the Pacific Ocean to the west for nearly all rainfall events. These overflow events cause beach closings due to bacterial contamination of coastal waters. Three primary WWTP's have a design capacity of 100 mgd and treat an average daily flow of 105 mgd with 84 mgd discharged to San Francisco Bay and 21 mgd to the Pacific Ocean.

The average annual rainfall in San Francisco is approximately 20.3 inches, ranging from an average monthly low of 0.02 inches in July to a high of 4.59 inches in January. About 40% of the annual rainfall occurs in December and January. Approximately 55 rainfall events occur each year with an average duration per event of 6 hours. Rainfall occurs for approximately 330 hours per year causing runoff for approximately 198 hours per year or 2.3% of the time.

Present receiving water uses include commercial and sport fishing, recreation, and navigation.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of San Francisco, California, are shown in Figure B-13. Combined sewer overflow is a major source of the average annual load for SS, 34%. Storm runoff is a major source of Pb and SS average annual loads, 80% and 52%, respectively; and secondary WWTP effluent is a major source of TN, PO_4, and BOD_5 average annual loads, 96%, 96%, and 74%, respectively.

Average annual loads in pounds per year from the area modeled by CH2M HILL for the wastewater facilities ocean outfall design are shown in Figure B-13. Combined sewer overflow is a minor source of average annual loads for all parameters. Storm runoff annual loads are zero since the entire city is served by combined sewers. Existing WWTP effluent is a major source of PO_4, TN, BOD_5, Pb and SS average annual loads, 93%, 92%, 90%, 70%, and 69%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of San Francisco, California, are shown in Figure B-13. Combined sewer overflow is a major source of SS and BOD_5 average event loads, 39% and 36%, respectively. Storm runoff is a major source of Pb, SS, BOD_5, TN, and PO_4 average event loads, 98%, 60%, 59%, 41%, and 38%, respectively; and secondary WWTP effluent is a major source of average event loads for all TN average event loads, 34%.

Average event loads in pounds per hour from the area modeled by CH2M HILL for the wastewater treatment facilities outfall design are shown in Figure B-13. Combined sewer overflow is a major source of SS, Pb, BOD_5, and TN average event loads 95%, 95%, 83%, and 80%, respectively. Storm runoff average event loads are zero since the entire city is served by combined sewers, and the existing WWTP effluent loads are a major source of the average event loads for PO_4 76%.

Sources of Information

1. Department of Public Works City and County of San Francisco, and J. B. Gilbert & Assoc. Overview Facilities Plan August 1975. San Francisco Master Plan Wastewater Management.

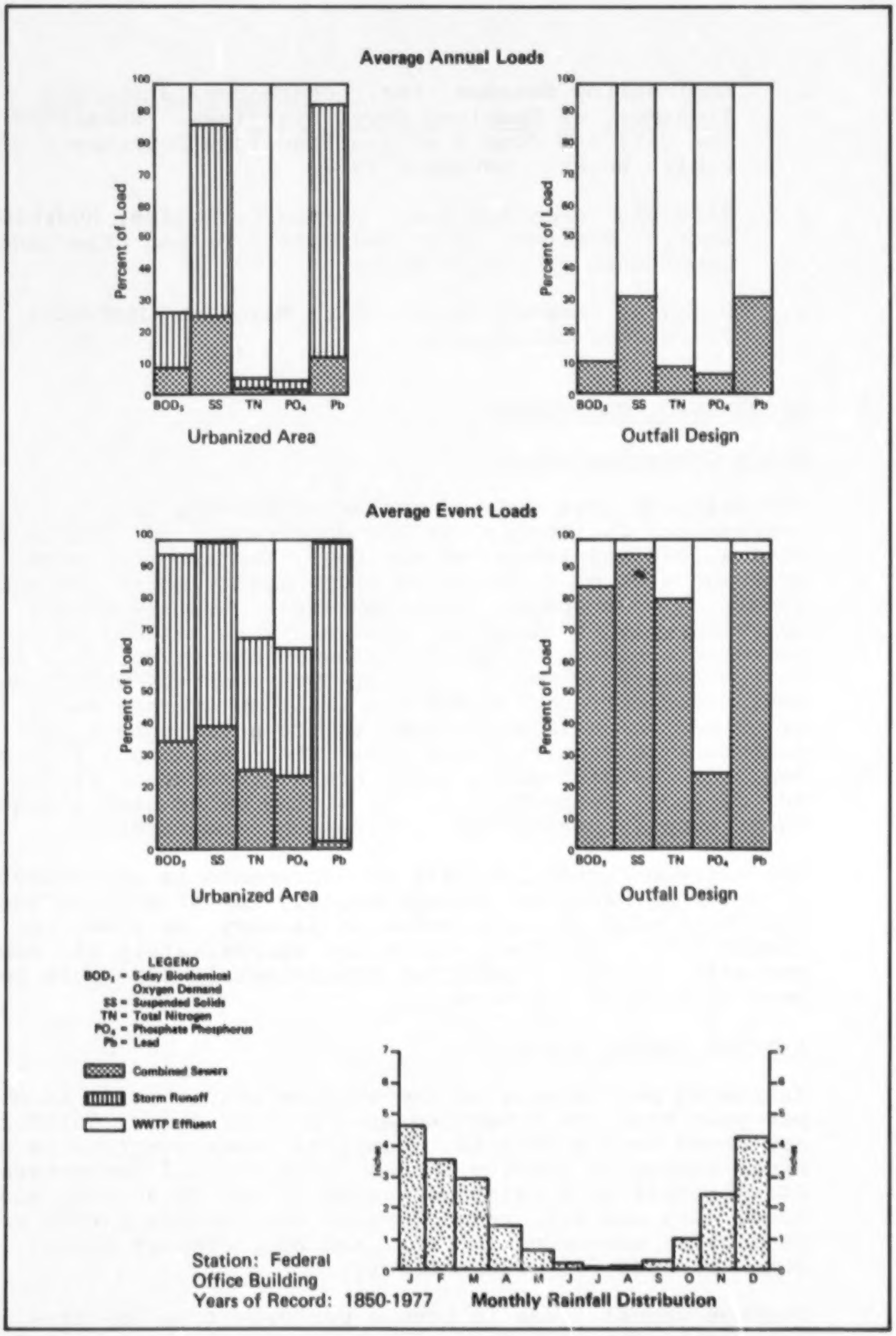


FIGURE B-13. Loading comparison for San Francisco, California.

2. Engineering Science, Inc. Characterization and Treatment of Combined Sewer Overflows. Submitted by the City and County of San Francisco Department of Public Works. November 1967.

3. Personal communication: Harold C. Coffee, Hydrology Section Engineer, City and County of San Francisco Department of Public Works.

4. Personal communication: Dick Meighan, CH2M Hill, San Francisco, California.

SACRAMENTO, CALIFORNIA

Urban Characteristics

The drainage area modeled by the 1978 Needs Survey for Sacramento, California, is 70,000 acres (109.4 square miles) with a 1970 population of 494,000. The combined sewer drainage area of 7,000 acres (10.9 square miles) is approximately 3% open space. Combined sewer overflow occurs approximately 40 times per year at two locations on the Sacramento River. These overflow events have little impact on the receiving water. Twenty-two secondary WWTP's have a design capacity of 148 mgd and treat an average daily flow of 98 mgd which is discharged to the Sacramento River, a tributary to San Francisco Bay. The mean annual flow and depth of the Sacramento River are approximately 24,000 cfs and 22 feet, respectively. Receiving water uses include water supply, navigation, recreation, and fishing.

The average annual rainfall in Sacramento is approximately 16.9 inches, from an average monthly low of 0.03 inches in July to a high of 3.50 inches in January, as shown in Figure B-14. Rainfall occurs for approximately 492 hours per year, causing runoff for approximately 288 hours per year or 3.3% of the time.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Sacramento, California, are shown in Figure B-14. Combined sewer overflow is a minor source of average annual loads for all parameters. Storm runoff is a major source of Pb and SS average annual loads, 86% and 63%, respectively; and secondary WWTP effluent is a major source of TN, PO_4, and BOD_5 average annual loads, 96%, 96%, and 73%, respectively.

Average annual loads in pounds per year from the area modeled by the 1978 Needs Survey are shown in Figure B-14.

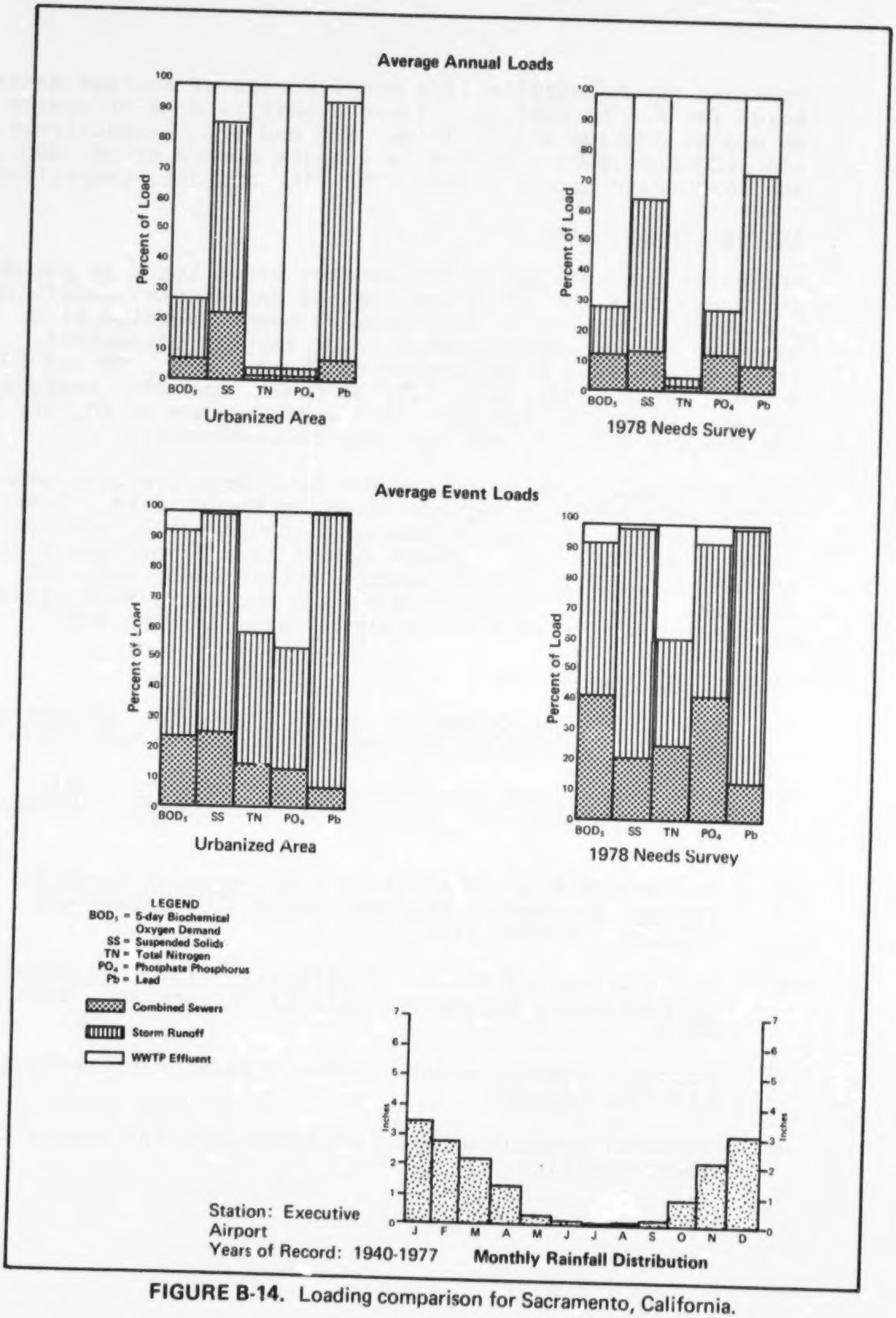


FIGURE B-14. Loading comparison for Sacramento, California.

Combined sewer overflow is a minor source of average annual loads for all parameters. Storm runoff is a major source of Pb and SS average annual loads, 62% and 51%, respectively; and secondary WWTP effluent is a major source of TN, BOD_5, and SS average annual loads, 95%, 73%, and 36%, respectively.

Average Event Loads

Estimated percentages of the average event loads in pounds per hours from the Urbanized Area of Sacramento, California, are shown in Figure B-14. Combined sewer overflow is a minor source of average event loads for all parameters. Storm runoff is a major source of Pb, SS, BOD_5, TN and PO_4 average event loads, 92%, 73%, 68%, 43%, and 40%, respectively; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 46% and 42%, respectively.

Average event loads in pounds per hour from the area modeled in the 1978 Needs Survey are shown in Figure B-14. Combined sewer overflow is a major source of BOD_5 and PO_4 average event loads, 42% each. Storm runoff is a major source of Pb, SS, BOD_5, PO_4, and TN average event loads, 86%, 78%, 50%, 50%, and 36%, respectively; and secondary WWTP effluent is a major source of average event loads for TN, 40%.

Sources of Information

1. U.S. EPA. Environmental Impact Statement, Sacramento Regional Wastewater Management Program. April 1975.

2. U.S. EPA. Urban Storm Runoff and Combined Sewer Overflow Pollution, Sacramento, California. December 1971.

3. Sacramento Area Consultants. Storm-water Control System, Sacramento Regional Wastewater Management Program. August 1975.

4. J. B. Gilbert & Assoc. Feasibility Study, Elimination of Wastewater Bypassing, City of Sacramento. September 1973.

5. Personal communication: Karen O'Hare, Sacramento Area Planning Council.

6. Personal communication: Bill Hetland, Sacramento City Sewer District.

PORTLAND, OREGON

Urban Characteristics

The drainage area modeled by the 1978 Needs Survey for Portland, Oregon, is served entirely by combined sewers with an area of 51,394 acres (80.3 square miles) and a 1970 population of 411,000. Only 6% of this area is open space. Combined sewer overflow occurs approximately 149 times per year at 43 locations on the Willamette River. These overflow events contribute to low dissolved oxygen concentrations and significant benthal deposits in the receiving water. Four secondary WWTP's have a design capacity of 9 mgd and treat an average daily flow of 7 mgd which is discharged to the Willamette River.

The average annual rainfall is approximately 37.6 inches, from an average monthly low of 0.49 inches in July to a high of 6.24 inches in December, as shown in Figure B-15. Rainfall occurs for approximately 1,496 hours per year, causing runoff for approximately 898 hours per year or 10% of the time. The mean annual flow and depth of the Willamette River are approximately 24,000 cfs and 25 feet, respectively. Receiving water uses include navigation, fishing, recreation, and swimming.

Average Annual Loads

Estimated percentages of the average annual loads in pounds per year from the Urbanized Area of Portland, Oregon, are shown in Figure B-15. Combined sewer overflow is a major source of the average annual load for SS, 59%. Storm runoff is a major source of lead and SS average annual loads, 70% and 36%, respectively; and secondary WWTP effluent is a major source of PO_4, TN, and BOD_5 average annual loads, 89%, 87%, and 54%, respectively.

Average annual loads in pounds per year from the hydrologic unit modeled by the 1978 Needs Survey are shown in Figure B-15. Combined sewer overflow is a major source of Pb, SS, BOD_5, PO_4 and TN average annual loads, 95%, 91%, 83%, 83%, and 63%, respectively. Storm runoff average annual loads are zero since the entire basin modeled is served by combined sewers. Secondary WWTP effluent is a major source of the average annual load for TN, 37%.

Average Event Loads

Estimated percentages of the average event loads in pounds per hour from the Urbanized Area of Portland, Oregon, are shown in Figure B-15. Combined sewer overflow is a major source of SS, BOD_5, TN, and PO_4 average event loads, 62%,

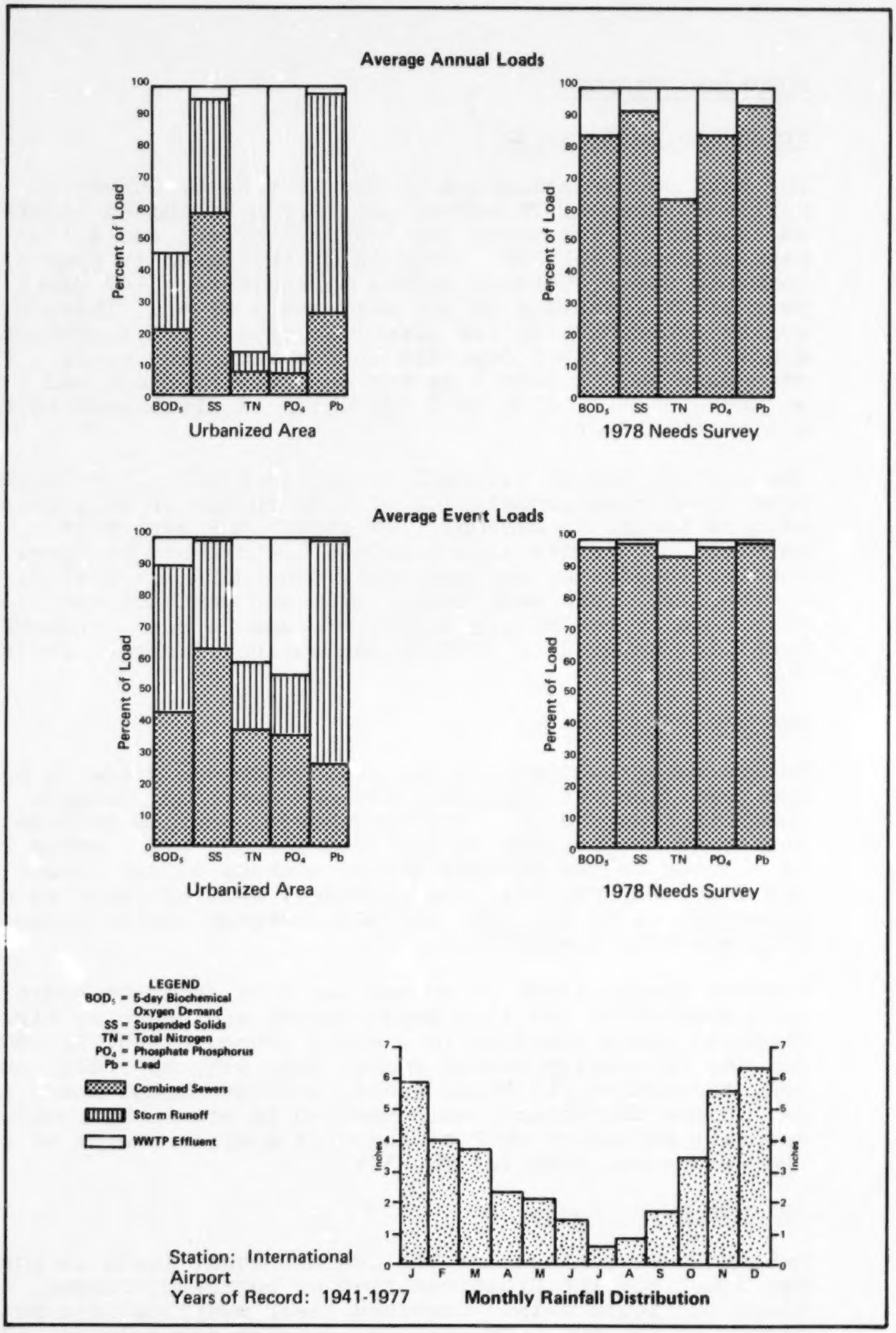


FIGURE B-15. Loading comparison for Portland, Oregon.

42%, 37%, and 34%, respectively. Storm runoff is a major source of Pb, BOD_5, and SS average event loads, 72%, 47%, and 38%, respectively; and secondary WWTP effluent is a major source of PO_4 and TN average event loads, 45% and 41%, respectively.

Average event loads in pounds per hour from the area modeled in the 1978 Needs Survey are shown in Figure B-15. Combined sewer overflow is a major source of Pb, SS, BOD_5, PO_4, and TN average event loads, 100%, 99%, 98%, 98%, and 94%, respectively. Storm runoff average event loads are zero since the entire basin modeled is served by combined sewers, and secondary WWTP effluent is a minor source of average event loads for all parameters.

Sources of Information

1. CH2M HILL. Proposed Plan Areawide Waste Treatment Management Study, Volume 1. Columbia Region Assoc. of Governments. November 15, 1977.
2. CH2M HILL. Portland 208 Plan, Technical Supplement No. 1, Planning Constraints. Columbia Region Assoc. of Governments. November 15, 1977.

APPENDIX C
DESCRIPTION OF TECHNOLOGICAL ALTERNATIVES

Appendix C
DESCRIPTION OF TECHNOLOGICAL ALTERNATIVES

Much of the information contained in Appendix C was abstracted from EPA reports published by the Municipal Environmental Research Laboratory Office of Research and Development in the Environmental Protection Technology Series. This series describes research performed to develop and demonstrate instrumentation, equipment, and methodology to repair or prevent environmental degradation from point and nonpoint sources of pollution. Specific reports consulted are listed for each technological alternative described in this appendix.

SOURCE CONTROLS

Management practices to control the accumulation of pollutants on an urban watershed cannot be considered as independent pollution control alternatives. They are part of a total pollution control plan and will play an increasingly important role in water pollution control as combined sewer overflow is reduced.

To control pollutants at their source, management practices must be applied where pollutants accumulate. For combined sewers, dry-weather deposition of sewage solids in the collection system is the major source of BOD_5, TN, PO_4 and coliform bacteria. Therefore, source control techniques such as sewer flushing, which operate in the collection system can be expected to be more effective than source control techniques such as street cleaning, which operate on the land surface for BOD_5 nutrients and coliform bacteria. On the other hand, lead is a pollutant which is associated with automobile use and accumulation is predominantly on the street surface. Therefore, if removal of lead is of concern in a combined sewer watershed, street cleaning can be expected to be more effective than sewer flushing to achieve the given objective.

Consideration of urban watersheds served by separate stormwater and wastewater collection systems is beyond the scope of this report. However, source controls which operate on the land surface or which affect pollution accumulation such as street cleaning, trash removal, and air pollution controls will generally be more effective on separate watersheds than on combined sewer watersheds, because the majority of the pollutants accumulate on the land surface rather than in the collection system.

Since BOD_5 is a major pollutant generated by combined sewer overflow and since data on the cost and effectiveness of BOD_5 removal are generally available, the unit removal cost of BOD, expressed in terms of dollars per pound removed, is used to compare the cost-effectiveness of the technological alternatives discussed in this report. If other pollutants are of interest in a given case, the relative cost-effectiveness of the various alternatives may change.

Street Cleaning

Process Description. The major objective of municipal street cleaning is to enhance the aesthetic appearance of streets by periodically removing the surface accumulation of litter, debris, dust, and dirt. Common methods of street cleaning are manual, mechanical broom sweepers, vacuum sweepers, and street flushing. However, as currently practiced, street flushing does not remove pollutants from storm water but merely transports them from the street into the sewers.

Streetsweeping has received a great deal of attention during the last few years as a potential water quality control management practice. It has the major advantage of being applicable to highly developed, established urban areas. It also controls pollutants at the source and will improve general urban aesthetics as well as water quality. Streetsweeping is a relatively inefficient control alternative for removing BOD_5 in a combined sewer watershed since only a small portion of the total BOD_5 load is located in or near street gutters. Therefore, streetsweeping will be more effective for watersheds served by separate sewers than for watersheds served by combined sewers.

Streetsweeping effectiveness is a function of sweeper efficiency, frequency of cleaning, number of passes, equipment speed, pavement conditions, equipment type, fraction of streets swept, litter control programs, and street parking restrictions.

Streetsweeping is a feasible control alternative for removal of between 2% and 11% of the BOD_5 discharge from a combined sewer watershed at a cost of \$3.00 to \$11.60 per pound of BOD_5 removed.

Advantages.

1. Source control of pollution may, in some cases, be cheaper than treatment.

2. Aesthetically better living conditions are provided.

3. Flexible to changing community needs.

4. Stimulates local employment. Approximately 65% to 70% of the annual cost is for labor and supervision.

5. Ease of application to highly developed urban areas.

Disadvantages.

1. Streetsweeping is applicable only to streets with curb and gutters.

2. Parking restrictions may be required for streetsweeping to be effective.

3. Streetsweepers consume approximately 1 gallon of gasoline for every 6 miles swept at a speed of 6 miles per hour.

Sources of Information.

1. "Areawide Assessment Procedures Manual, Volume III, Appendix G, Urban Stormwater Management Techniques: Performance and Cost," EPA-6009-76-014. MERL Office of Research and Development, U.S. EPA, Cincinnati, Ohio. July 1976.

2. Sartor, J. D. and Boyd, G. B. "Water Pollution Aspects of Street Surface Contaminants," U.S. EPA No. EPA-R2-72-081. NTIS No. PB 214 408. Office of Research and Monitoring, Washington, D.C. November 1972.

3. American Public Works Association. "Water Pollution Aspects of Urban Runoff." EPA-R2-72-081. NTIS No. PB 215 532. U.S. EPA. January 1969.

4. Levis, A. H. "Urban Street Cleaning," EPA-670/2-75-030. NTIS No. PB 239 327.

5. Amy, G. et al. "Water Quality Management Planning for Urban Runoff." U.S. EPA No. EPA 440/9-75-004. NTIS No. PB 241 689. December 1974.

6. Adimi, R. et al. "An Evaluation of Streetsweeping Effectiveness in the Control of Nonpoint Source Pollution." The Catholic University of America. April 1976. (Unpublished paper prepared under the direction of G. K. Young, Ph.D.).

Combined Sewer Flushing

Process Description. The major objective of combined sewer flushing is to resuspend deposited sewage solids and transmit these solids to the dry-weather treatment facility before a storm event flushes them to a receiving water. Combined sewer flushing consists of introducing a controlled volume of water over a short duration at key points in the collection system. This can be done using external water from a tanker truck with a gravity or pressurized feed or using internal water detained manually or automatically.

Combined sewer flushing is most effective when applied to flat collection systems. It may also be applied in conjunction with upstream storage and downstream swirl concentrators, followed by disinfection. Procedures are available to estimate the quantity and distribution of dry-weather deposition in sewers and for locating the optimum sites for sewer flushing. A recent feasibility study of combined sewer flushing indicates that manual flushing using an external pressurized source of water is most effective. No significant gain in the fraction of load removed was achieved by repeated flushing, and 70% of the flushed solids will quickly resettle. Therefore, repeated flushing in a downstream sequence is probably necessary to achieve significant pollutant reductions. Process efficiency is dependent upon flush volumes, flush discharge rate, sewer slope, length, diameter, wastewater flow rate, and efficiency of the wastewater treatment device receiving the resuspended solids.

Combined sewer flushing is a feasible control alternative for removal of between 18% and 32% of the BOD_5 discharge from a combined sewer watershed at a cost of 0.94 to 4.00 per pound of BOD_5 removed.

Advantages.

1. Implementation of sewer flushing requires a complete knowledge of how the existing system is operating.
2. Increases the sewer transport and storage capacity.
3. Flexible to the needs and characteristics of a specific site.
4. Flexible to changes in facility capacities.

Disadvantages.

1. Experience with large-scale combined sewer flushing is limited.
2. A continuous operation and maintenance program is required.

Sources of Information.

1. Pisano, W. C. and Queiroz, C. S. "Procedures for Estimating Dry Weather Pollutant Deposition in Sewerage Systems." EPA-600/2-77-120. July 1977.

2. FMC Corporation. "A Flushing System for Combined Sewer Cleansing." EPA 11020 DNO 03/72. March 1972.

3. Process Research, Inc. "A Study of Pollution Control Alternatives for Dorchester Bay." Commonwealth of Mass. Metro. District Commission. Volumes 1, 2, 3, and 4. 23 December 1974.

4. Smith, S. F. "Statement for the Record--Subcommittee on Investigations and Review--Committee on Public Works and Transportation--U.S. House of Representatives--On Oversite Hearings on Municipal Construction Grants Program." 3 August 1978.

Catch Basin Cleaning

Process Description. The major objective of catch basin cleaning is to reduce the first flush of deposited solids in a combined sewer system by frequently removing accumulated catch basin deposits. Methods to clean catch basins are, manual, eductor, bucket, and vacuum. Less than 45% municipalities in the United States uses mechanical methods.

The role of catch basins in newly constructed sewers is marginal due to improvements in street surfacing and design methods for providing self-cleaning velocities in sewers. Catch basins should be used only where there is a solids-transporting deficiency in the downstream sewers or at a specific site where surface solids are unusually abundant; however, many existing combined sewers have catch basins. A national survey of catch basin cleaning indicates that the average cleaning frequency of 2.3 times/year has the potential for removing approximately 2% of a combined sewer watershed BOD_5 load with a unit removal cost of greater than $50 per pound of BOD. Therefore, catch basin cleaning cannot be considered a feasible pollution control alternative for combined sewer systems.

Advantage.

1. Site-specific combined sewer deposition and flushing problems can be controlled.

Disadvantage.

1. Low overall removal efficiency.

Sources of Information.

1. Lager, J. A., Smith, W. G., and Tchobanoglous, G. "Catchbasin Technology Overview and Assessment." EPA-600/2-77-051. May 1977.

COLLECTION SYSTEM CONTROLS

Existing System Management

Process Description. The major objective of collection system management is to implement a continual remedial repair and maintenance program to provide maximum transmission of flows for treatment and disposal while minimizing overflow, bypass, and local flooding. It requires an understanding of how the collection system works and patience to locate unknown malfunctions of all types, poorly optimized regulators, unused in-line storage, and pipes clogged with sediments in old combined sewer systems.

The first phase of analysis in a sewer system study is an extensive inventory of data and mapping of flowline profiles. This information is then used to conduct a detailed physical survey of regulator and storm drain performance. In a detailed study at Fitchburg, Massachusetts, Pisano (May 1978) found that minor repairs of four overflow structures and several small alterations of storm sewer piping obtained a 43.9% reduction of the present BOD load due to combined sewer overflow at a cost of $26,500. An additional 23% BOD reduction was obtained at a cost of $4,678,000 using sewer flushing, streetsweeping, inflow correction and storage. This type of sewer system inventory and study should be the first objective of any combined sewer overflow pollution abatement project.

Advantages.

1. Requires a thorough analysis of the existing sewer system which will result in an understanding of how the collection system operates before control alternatives are chosen.

2. Regulator modification and storm drain repiping can be very cost-effective.

3. Application is very flexible to site-specific conditions.

Disadvantages.

1. No general cost-effectiveness data are available since the results are very site-specific.

Sources of Information.

1. Pisano, W. C. "Analyzing the Existing Collection System." Paper presented at a seminar on combined sewer overflow assessment and control procedures. Windsor Locks, Connecticut. May 1978.

Flow Reduction Techniques

Process Description. The major objective of flow reduction techniques is to maximize the effective collection system and treatment capacities by reducing extraneous sources of clean water. Infiltration is the volume of ground water entering sewers through defective joints; broken, cracked, or eroded pipe; improper connections; and manhole walls. Inflow is the volume of any kind of water discharged into sewerlines from such sources as roof leaders, cellar and yard drains, foundation drains, roadway inlets, commercial and industrial discharges, and depressed manhole covers. Combined sewers are by definition intended to carry both sanitary wastewater and inflow. Therefore, flow reduction opportunities are limited. Typical methods for reducing sewer inflow are by discharging roof and areaway drainage onto pervious land, use of pervious drainage swales and surface storage, raising depressed manholes, detention storage on streets and rooftops, and replacing vented manhole covers with unvented covers.

It appears that the disconnection of roof drains from combined sewer systems would have limited effectiveness since very little of the pollutant load accumulates on roofs. Therefore, total annual pollutant yield would be largely unaffected. However, the frequency of overflow may be reduced since total runoff would be reduced somewhat.

Advantages.

1. Application is very flexible to site-specific conditions.

2. Requires a thorough analysis of the existing sewer system before alternatives are chosen.

3. Maximizes the effective capacities of collection system and treatment works.

Disadvantages.

1. No general cost-effectiveness data are available since the results are very site-specific.

2. Extraneous flow problems are not simple to solve, and opportunities are limited in combined sewers.

3. Detention storage on streets has the potential of disrupting traffic and business activity.

4. Rooftop storage and roof drain disconnection require the cooperation of building owners.

Sources of Information.

1. Sullivan, R. H. et al. "Sewer System Evaluation, Rehabilitation and New Construction, A Manual of Practice." EPA-600/2-77-017d.

2. Cesareo, D. J. and Field, R. "Infiltration-Inflow Analysis." J. Env. Eng. Div. ASCE. Vol. 101, No. 5, pp. 775-784. October 1975.

3. Respond, F. J. "Roof Retention of Rainfall to Limit Urban Runoff." National Symposium on Urban Hydrology, Hyd. and Sed. Control, July 26-29, 1976. Kentucky Univ. Office Resident Eng. Service Bull. N III 115. 1976.

4. Poertner, H. G. "Detention Storage of Urban Stormwater Runoff." APWA Reporter. 40, 5:14. 1973.

5. Poertner, H. G. "Better Storm Drainage Facilities at Lower Costs." Civil Eng. 43, 10:67. 1973.

6. Peters, G. L. and Troemper, O. P. "Reduction of Hydrualic Sewer Loadings by Downspout Removal." JWPCF 41, 4:63-81. 1969.

Sewer Separation

Process Description. Sewer separation is the conversion of a combined sewer system into separate sanitary and storm sewer systems. Separation of municipal wastewater from storm water can be accomplished by adding a new sanitary sewer and using the old combined sewer as a storm sewer, by adding a new storm sewer and using the old combined sewer as a sanitary sewer, or by adding a "sewer within a sewer" pressure system. If combined sewers are separated it must be remembered that storm sewer discharges may contribute a significant pollutant load relative to secondary wastewater treatment plant effluent and, therefore, may require some type of control even after the sewer systems are separated.

Sewer separation is a feasible control alternative for small combined sewer systems. Sewer separation will remove between 0% and 65% of the BOD_5 discharge from a combined sewer watershed at a cost of approximately $24.00 per pound of BOD_5.

Advantages.

1. All municipal wastewater is treated prior to discharge.
2. Wastewater treatment plants operate more efficiently under the relatively stable sanitary flow conditions.
3. Increased construction employment.
4. By definition, combined sewer overflow is eliminated.

Disadvantages.

1. Traffic and business activity is disrupted during a long construction period.
2. It is difficult to eliminate all sanitary connections to storm sewers.
3. Sewer separation is not flexible to changing water pollution control needs.

Sources of Information.

1. American Society of Civil Engineers. "Combined Sewer Separation Using Pressure Sewers." EPA 110020 EKO. October 1969.
2. C-E Maguire, Inc. "Storm Water--Wastewater Separation Study, City of Norwich, Connecticut." Engineering Report. May 1976.
3. Albertson, Sharp and Backus, Inc. "City of Norwalk, Connecticut, Facilities Plan Update for Sewerage System." Engineering Report. June 1977.

Swirl and Helical Concentrators

Process Description. The major objective of swirl and helical concentrators is to regulate both the quantity and quality of storm water at the point of overflow. Solids separation is caused by the inertia differential which results from a circular path of travel. The flow is separated into a large volume of clear overflow and a concentrated low volume of waste that is intercepted for treatment at the wastewater treatment plant. In addition to regulation of combined sewer flow, they can provide high-rate primary treatment for solids removal. A major attribute of the swirl concentrator is the relatively constant treatment efficiency over a wide range of flow rates (a fivefold flow increase results in only about a 25% efficiency reduction) and the absence of mechanical parts which use energy unless input or output pumping is required.

Swirl and helical bend concentrators have been modeled and, in several cases, demonstrated for various processes including treatment and flow regulation, primary treatment, and erosion control. Swirl concentrators have been operated in Syracuse, New York, from 1974 to present, in Rochester, New York, from 1975 to 1977, and in Toronto, Ontario, Canada, from 1975 to 1977. Helical bends have been operated in Lasalle, Quebec, Canada, and Nantwich, England.

Swirl concentrators are a feasible control alternative to remove between 33% and 56% of the BOD_5 discharge from a combined sewer watershed at a cost of \$2.30 to \$3.00 per pound of BOD_5. These cost estimates include pumping.

Advantages.

1. Operation and maintenance costs are low.
2. Operates well under intermittent shock loading conditions.
3. Very flexible and stageable to site-specific needs.
4. Requires no energy except that needed to recover hydraulic head losses through the system, or for pumping through the concentrator.

Disadvantages.

1. Experience with full-scale operation of swirl concentrators is limited.
2. Swirl concentrators do not remove dissolved pollutants.

Sources of Information.

1. Sullivan, R. H. et al. "The Helical Bend Combined Sewer Overflow Regulator." EPA-600/2-75-062. December 1975.
2. "The Swirl Concentrator as a Grit Separator Device." EPA-670/2-74-026.
3. Sullivan, R. H. et al. "Relationship Between Diameter and Height for the Design of a Swirl Concentrator as a Combined Sewer Overflow Regulator." EPA-670/2-74-039.
4. Sullivan, R. H. et al. "The Swirl Concentrator for Erosion Runoff Treatment." EPA-600/2-76-271. September 1975.

Remote Monitoring and Control

Process Description. The major objective of remote monitoring and control on a combined sewer collection system is to remotely observe the sewer and treatment capacities so that the most effective use of inline storage is obtained with a minimum of severe overflow. A prerequisite for this alternative is a large collection system with the potential for inline storage. Three components are generally added to the existing collection system: a data gathering system for reporting rainfall, pumping rates, treatment rates, and regulator positions; a central computer processing center, and a control system to remotely manipulate gates, valves, regulators, and pumps. The capital costs, operation and maintenance costs, and effectiveness depend on the hydraulic characteristics of the system of concern and thus are very site-specific. Remote monitoring and control of combined sewer flow is presently used to reduce overflow in Detroit, Michigan, and Seattle, Washington.

Remote monitoring and control is a feasible control alternative only if a significant in-line storage volume exists. Available site-specific data indicate that a 20% to 45% removal of the BOD_5 discharge from a combined sewer watershed is possible at a cost of $1.25 to $4.00 per pound of BOD_5.

Advantages.

1. Utilizes the in-line storage capacity of the existing system.
2. Low unit removal costs are possible.
3. Attenuation of peak flows is achieved.
4. The first flush is captured.

Disadvantages.

1. Limited to sites with large collection systems and large interceptors which can be used for storage.
2. Requires highly trained operators and computer facilities.
3. There is no easy method of removing settled solids; they may be bypassed to receiving waters during high flows.
4. Devices to provide in-line storage may restrict peak sewer capacity.

Sources of Information.

1. Leiser, C. P. "Computer management of a combined sewer system by METRO SEATTLE." EPA-670/2-74-022.

2. Metropolitan Sewer Board--St. Paul, Minnesota. "Dispatching System for Control of Combined Sewer Losses." EPA Report No. 11020FAQ03/71. March 1971.

3. Watt, T. R. et al. "Sewerage System Monitoring and Remote Control." EPA-670/2-75-020. May 1975.

4. Smith, S. F. "Statement for the Record--Subcommittee on Investigations and Review--Committee on Public Works and Transportation--U.S. House of Representatives--On Oversite Hearings on Municipal Construction Grants Program." 3 August 1978.

Fluidic Regulations

Process Description. The major objective of fluidic combined sewer overflow regulation is to provide dynamic control at the site of overflow without a complex operational system. They are self-operated by using a venturi pressure gradient which senses the dry-weather interceptor sewer capacity before allowing combined storm water to overflow. New fluidic regulator capital costs are estimated to be 10% greater than conventional static regulators. A fluidic regulator demonstration program operated in Philadelphia, Pennsylvania, from February 1971 to March 1975.

Advantages.

1. Provides dynamic control of combined sewer overflow without complex operational systems.

2. Reliability of operation and low maintenance.

3. Subject to real time control operation.

Disadvantages.

1. Experience with in-system operation is limited.

2. Higher capital costs than conventional regulators.

Sources of Information.

1. Freeman, P. A. "Evaluation of Fluidic Combined Sewer Regulators Under Municipal Service Conditions." EPA-600/2-77-071. August 1977.

Polymer Injection

Process Description. The primary objective of polymer injection to sewer flow is to increase the flow capacity of an existing sewer by reducing the turbulent friction. It is most applicable as an interim solution to infiltration problems of sanitary sewers since they respond slowly over a long period to rainfall-induced infiltration. A rapid short duration flow increase, such as that occurring in combined sewers, will generally exceed the capacity of polymer friction reduction. Polymers used are water soluble, have a high molecular weight and a large length-to-diameter ratio, and are not toxic or harmful if swallowed.

Advantages.

1. Can reduce sanitary sewer overflow and flooding problems due to rainfall-induced infiltration.
2. Low-cost solution to sanitary sewer infiltration problems.

Disadvantages.

1. Polymer lumping and injection failures.
2. Increased sanitary sewer flows may exceed the wastewater treatment plant capacity.
3. Polymer injection will have little impact on combined sewer overflow.

Sources of Information.

1. Chandler, R. W. and Lewis, W. R. "Control of Sewer Overflows by Polymer Injection." EPA-600/2-77-189. September 1977.

TREATMENT FACILITIES

Offline Storage

Process Description. The major objective of offline storage is to contain combined sewer overflow for controlled release into treatment facilities. Offline storage provides a more uniform constant flow and thus reduces the size of treatment facilities required. Offline storage facilities may be located at overflow points or near dry-weather or wet-weather treatment facilities. A major factor determining the feasibility of using offline storage is land availablity. Operation and maintenance costs are generally small, requiring only collection and disposal costs for sludge solids, unless input or output pumping is required. Many demonstration projects have included storage of peak storm-water flows.

These include Chipewa Falls, Wisconsin, Boston, Massachusetts, Milwaukee, Wisconsin, and Columbus, Ohio.

Offline storage is a feasible control alternative to remove between 2% and 22% of the BOD_5 discharge from a combined sewer watershed at a cost of \$1.60 to \$5.60 per pound of BOD_5. However, the primary objective of offline storage is to capture the runoff waters for subsequent treatment by a separate wet-weather treatment plant or combined wet/dry weather treatment facility.

Advantages.

1. Reduces the size of required treatment facilities by equalizing combined sewer overflow.
2. Flexible operation and adapts well to staged construction.
3. Can provide multipurpose services (recreational or aesthetic designs).
4. Simple in design and operation.
5. Storage alone may remove up to 30% of the BOD captured depending upon detention time.

Disadvantages.

1. Suitable land area must be available.
2. Additional treatment facilities are usually required.
3. Standing water may provide an environment that breeds mosquitoes and results in odor and algae problems.

Sources of Information.

1. Liebenow, W. R. and Bieging, J. K. "Storage and Treatment of Combined Sewer Overflow." EPA-R2-72-070. October 1972.
2. Commonwealth of Massachusetts, Metropolitan District Commission. "Cottage Farm Combined Sewer Detention and Chlorination Station." EPA-600/2-77-046. November 1976.
3. City of Milwaukee, Wisconsin, and Consoer, Townsend, and ASSO. "Detention Tank for Combined Sewer Overflow, Milwaukee, Wisconsin, Demonstration Project." EPA-600/2-75-071. December 1975.

4. Dodson, Kinney, and Lindbolm. "Evaluation of Storm Standby Tank, Columbus, Ohio." EPA No. 11020FAL03/71 March 1971.

Sedimentation

Process Description. The major objective of sedimentation is to produce a clarified effluent by gravitational settling of the suspended particles that are heavier than water. It is one of the most common and well-established unit operations for wastewater treatment. Sedimentation also provides storage capacity, and disinfection can be effected concurrently in the same tank. It is also very adaptable to chemical additives such as lime, alum, ferric chloride, and polymers which provide higher suspended solids, BOD, nutrients and heavy metals removal. Many demonstration projects have included sedimentation. These include Dallas, Texas, New York City, New York, Saginaw, Michigan, and Mt. Clemens, Michigan.

Advantages.

1. The process is familiar to design engineers and operators.

2. Simple in design and operation.

3. Flexible operation and adapts well to staged construction.

4. Disinfection can be effected concurrently with sedimentation in the same tank.

5. Storage is provided in conjunction with sedimentation.

6. Chemical additives can be used to improve process removal efficiencies.

7. Energy requirements are usually low.

Disadvantages.

1. High land requirement.

2. Some manual basin cleaning must be provided between storm events.

3. Removal performance is sensitive to the duration of peak combined sewer overflow rates.

Sources of Information.

1. Mahida, V. U. and DeDecker, F. J. "Multi-Purpose Combined Sewer Overflow Treatment Facility, Mount Clemens, Michigan." EPA-670/2-75-010. May 1975.

2. Metcalf and Eddy, Inc. *Wastewater Engineering*. McGraw-Hill, 1972.

3. Wolf, H. W. "Bachman Treatment Facility for Excessive Storm Flow in Sanitary Sewers." EPA-600/2-77-128.

4. Feurstein, D. L. and Maddaus, W. O. "Wastewater Management Program, Jamaica Bay, New York, Volume I: Summary Report." EPA-600/2-76-222a. September 1976.

5. *Process Design Manual for Suspended Solids Removal*. EPA Technology Transfer. EPA 625/1-75-003a. January 1975.

Dissolved Air Flotation

Process Description. The major objective of dissolved air flotation (DAF) is to achieve suspended solids removal in a shorter time than conventional sedimentation by attaching air bubbles to the suspended particles. The principal advantage of flotation over sedimentation is that very small or light particles that settle slowly can be removed more completely and in a shorter time. Capital costs for DAF are moderate; however, operating costs are relatively high due to the energy required to compress air and release it into the flotation basin and due to the greater skill required by operators. Chemical additives are also useful to improve process efficiencies of BOD and SS removals and to obtain nitrogen and phosphorus removals. DAF demonstration facilities were operated in Milwaukee, Wisconsin, from 1969 to 1974, in Racine, Wisconsin, from 1973 to present, and in San Francisco, California, from 1970 to present.

Advantages.

1. Chemical additives can be used to improve the process removal efficiencies.

2. High rate intermittent operation is reliable.

3. Smaller sludge volumes and basin than for sedimentation.

4. Land requirements are smaller than for conventional sedimentation.

Disadvantages.

1. Operating costs are relatively high.

2. Energy needs are much higher than for conventional sedimentation.

3. Greater skill is required for operation.

Sources of Information.

1. Bursztynsky, J. A. et al. "Treatment of Combined Sewer Overflow by Dissolved Air Flotation." EPA-600/2-75-033. September 1975.

2. Rex Chainbelt, Inc. "Screening/Flotation Treatment of Combined Sewer Overflows." EPA 11020FDC. January 1972.

3. White, R. L. and Cole, T. G. "Dissolved Air Flotation for Combined Sewer Overflows." Public Works. Vol. 104 No. 2, pp. 50-54. 1973.

4. Gupta, M. K. et al. "Screening/Flotation Treatment of Combined Sewer Overflow, Volume 1 Bench Scale and Pilot Plant Investigations." EPA-600/2-77-069a. August 1977.

Screens

Process Description. The major objective of screening is to provide high-rate solids/liquid separation for combined sewer particulate matter. Four basic screening devices have been developed to serve one of two types of applications. The microstrainer is a very fine screening device designed to be the main treatment process of a complete system. The other three devices, drum screens, rotary screens, and static screens, are basically pretreatment devices designed to remove coarse materials. BOD removal efficiencies are approximately 15% for pretreatment screens and up to 50% for microstrainers. For all screens, removal performance tends to improve as influent suspended solids concentrations increase due to the relatively constant effluent concentrations. In addition, screens develop a mat of trapped particles which act as a strainer retaining particles smaller than the screen aperture. Chemical additives can be used to improve process removal efficiencies. The use of screens in series does not show any advantage over the use of a single screen. Microstrainers break up solid particles and expose greater numbers of bacteria in the effluent to disinfection.

Microstrainers have operated at Mt. Clemens, Michigan from 1972 to 1975, at Philadelphia, Pennsylvania, from 1969 to 1974, at Rochester, New York, from 1975 to 1976, at Oil City, Pennsylvania, from 1976 to present, and several projects are now under construction. Rotary, disc, and drum screens have operated at Cleveland, Ohio, from 1970 to 1971, at Milwaukee, Wisconsin, from 1969 to 1974, and at New York City, New York, from 1975 to present.

Microscreening is a feasible control alternative for removal of between 22% and 43% of the BOD_5 discharge from a combined sewer watershed at a cost of $1.70 to $2.40 per pound of BOD_5.

Advantages.

1. Capable of treating highly varying flows under intermittent conditions.
2. Flexible to site-specific operation needs by providing pretreatment or main treatment.
3. Suspended solids removals of up to 70% are achievable.
4. The concentrated waste solids flow is usually less than 1% of the total flow, and the sludge is amenable to dewatering.
5. Small land requirement.
6. Adaptable to automatic operation.
7. Microstrained effluent is more easily disinfected due to solids breakup.

Disadvantages.

1. Removes only particulate matter.
2. Optimal use of chemical additives is not always possible due to widely varying influent characteristics.
3. Operational problems include screen binding due to oil and grease buildup and biological growth on the screen panels.
4. High-impact velocities tend to break up solids and flocs if chemical additives are used.

Sources of Information.

1. Gupta, M. K. et al. "Screening/Flotation Treatment of Combined Sewer Overflow, Volume 1--Bench Scale and Pilot Plant Investigations." EPA-600/2-77-069a. August 1977.
2. Maher, M. B. "Microstraining and Disinfection of Combined Sewer Overflow--Phase III." EPA-670/2-74-049. August 1974.

3. Clark, M. J. et al. "Screening/Flotation Treatment of Combined Sewer Overflow, Volume II: Full-Scale Demonstration." U.S. EPA Demonstration Grant No. 11023 FWS. Draft Report. April 1975.

4. Prah, D. H. and Brunner, P. L. "Combined Sewer Stormwater Overflow Treatment by Screening and Terminal Ponding at Fort Wayne, Indiana." U.S. EPA Demonstration Grant No. 11020 GYU. Volumes 1 and 2. Draft Report. June 1976.

5. Neketin, T. H. and Dennis, H. K. Jr. "Demonstration of Rotary Screening for Combined Sewer Overflow." EPA No. 11023 FDD 07/71. July 1971.

High-Rate Filtration

Process Description. The major objective of high-rate filtration (HRF) is to capture suspended solids on a fixed bed of anthracite coal and on sand filter media. Periodic backwashing of the filter bed must be provided even if prefiltration is used because suspended solids will clog the filter. HRF has been developed over the past 15 years and is used in a variety of treatment applications, mainly for industrial wastewater treatment. A pilot plant study of HRF at the New York City Newton Creek Wastewater Treatment Plant found that chemical additives improved HRF performance; however, above 25 mgd, the extra cost of chemicals was higher than the increased removals. Estimated unit treatment costs in dollars per million gallons treated at the Newtown Creek HRF were reduced approximately 80% when the HRF was used as a dual treatment process. HRF demonstration facilities were operated in Cleveland, Ohio, from 1970 to 1971, in Rochester, New York, from 1975 to 1976, and in New York City from 1975 to 1978.

Advantages.

1. Well suited to automatic operation.

2. Flexible in capacity to site-specific needs.

3. Backwash volume is usually less than 6% of the treated flow, and sludge is amenable to dewatering.

4. Adaptable to dual treatment, i.e., dry-weather sanitary sewage and combined sewer overflow, which reduces annual costs by approximately 80%.

5. HRF in dual functions increases the capacity of overloaded dry-weather treatment plants.

6. Land requirements for HRF units are only 7% to 10% of that needed for primary clarifiers of the same capacity.

Disadvantages.

1. HRF operation is hindered by the accumulation of compressible organic solids on the filter media.
2. Pretreatment is required to remove coarse solids.
3. Limited full-scale experience.
4. HRF does not remove dissolved pollutants.
5. Moderately high energy use.

Sources of Information.

1. Nebolsine, R. N. et al. "High Rate Filtration of Combined Sewer Overflow." EPA 11023 EY 104/72. April 1972.
2. Innerfeld, H. et al. "Dual Process High-Rate Filtration of Raw Sanitary Sewage and Combined Sewer Overflow." U.S. EPA Grant No. S 803271. Draft Report. July 1978.
3. Drehwing, F. J. et al. "Combined Sewer Overflow Abatement Program, Rochester, N.Y. Pilot Plant Evaluations." U.S. EPA Grant No. Y005141. Draft Report. 1977.
4. Hickok, E. A. et al. "Urban Runoff Treatment Methods Volume II--High-Rate Pressure Filtration." U.S. EPA Grant No. S-802535. At Press. 1977.
5. Murphy, C. B. et al. "High Rate Nutrient Removal for Combined Sewer Overflow." U.S. EPA Grant No. S-802400. At Press. 1977.

High Gradient Magnetic Separation

Process Description. The major objective of high gradient magnetic separation (HGMS) is to bind suspended solids to small quantities of a magnetic seed material (iron oxide called magnetite) by chemical coagulation and then pass them through a high gradient magnetic field for removal. Magnetic separation techniques have been used since the 19th century to remove tramp iron and to concentrate iron ores. Solids are trapped in a magnetic matrix which must be cyclically back-flushed like screens and filters. Research on the application of HGMS to combined sewer overflow pollutant removal has been performed since July 1975 by Sala Magnetics, Inc., in Cambridge, Massachusetts.

Advantages.

1. Well suited to automatic operation.
2. Flexible to large variations in flow rate and influent character without substantial changes in effluent quality.
3. Estimated capital costs are approximately 40% lower than comparative physical-chemical treatment.
4. Estimated operation and maintenance costs are approximately 20% lower than comparative physical-chemical treatment.
5. Adaptable as a dual function treatment facility for CSO and dry-weather sanitary sewage.
6. Land requirements for magnetic separation are small.
7. Lower chlorine demand for disinfection.
8. BOD_5 removals higher than 92% are possible with a detention time of only 3 minutes.
9. Provides nutrient and heavy metals removals.
10. Reduced sludge dewatering costs.

Disadvantages.

1. No full-scale facilities have been constructed to treat CSO or sanitary sewage.
2. Proper alum-polyelectrolyte flocculation is essential to high gradient magnetic separation.
3. The ratio of magnetite seed to suspended solids is critical for effective operation.

Sources of Information.

1. Allen, D. M., Sargent, R. L. and Oberteuffer, J. A. "Treatment of Combined Sewer Overflow by High Gradient Magnetic Separation." EPA-600/2-77-015. March 1977.
2. Kolm, H., Oberteuffer, J. A. and Keeland, D. "High Gradient Magnetic Separation." Scientific American, 233(5):46-54, 1975.
3. Oder, R. R. and Horst, B. I. "Wastewater Processing with High Gradient Magnetic Separators (HGMS)." Presented at the 2nd National Conference on Complete Water Reuse, Chicago. May 1975.

4. Bitton, G. et al. "Phosphate Removal by Magnetic Filtration." Water Research, 8:107. 1974.

5. Bitton, G. and Mitchell, R. "Removal of E. coli Bacteriophage by Magnetic Filtration." Water Research 8:548. 1974.

Chemical Additives

Process Description. The major objective of using chemical additives is to provide a higher level of treatment than is possible with unaided physical treatment processes (sedimentation, dissolved air flotation, high rate filtration, and high gradient magnetic separation). Chemicals commonly used are lime, aluminum or iron salts, polyelectrolytes, and combinations of these chemicals. There is no rational method for predicting the chemical dose required. Jar tests are used for design purposes; however, field control is essential since the chemical composition of combined sewer overflow is highly variable. The major advantage of using chemical additives with physical treatment is the increased pollutant removals including removal of dissolved parameters. The major disadvantages of using chemical additives are the higher energy and treatment costs, greater sludge volumes, and the necessity of experienced personnel to monitor the application of chemicals. Many full-scale physical treatment facilities use chemical additives.

Advantages.

1. Well suited to automatic control.
2. It can significantly increase pollutant removals, including removal of heavy metals, by physical processes.
3. It can provide removal of dissolved pollutants.
4. Lime sludge can be recalcined for lime recovery if this proves economical.

Disadvantages.

1. Increased volumes of sludge.
2. Higher energy needs.
3. Higher treatment costs.
4. Experienced personnel are required to monitor the application of chemicals.

Sources of Information.

1. Weber, W. J. Jr. Physicochemical Processes for Water Quality Control. Wiley--Interscience. 1972.

Carbon Adsorption

Process Description. The major objective of carbon adsorption is to remove soluble organics as part of a complete physicochemical treatment system that usually includes preliminary treatment, sedimentation with chemicals, filtration, and disinfection. Carbon contacting can be done using either granular activated carbon in a fixed or fluidized bed or powdered activated carbon in a sedimentation basin. Periodic backwashing of the fixed bed must be provided, even if prefiltration is used, because suspended solids will accumulate in the bed. A physicochemical treatment system utilizing powdered activated carbon, coagulated with alum, settled with polyelectrolyte addition, and in some cases, passed through a trimedia filter was demonstrated in Albany, New York, during 1971 and 1972, to treat combined sewer overflow. Application of carbon adsorption is well suited to advanced waste treatment of sanitary sewage. However, the feasibility of application to combined sewer overflow is dependent upon the effluent quality objectives, the degree of preunit flow attenuation, and the ability to obtain dual dry- and wet-weather use of treatment facilities.

Advantages.

1. Well suited to automatic control under intermittent conditions.

2. High quality effluent (BOD removal efficiencies greater than 94%) at a detention time of 50 minutes or less.

3. Adaptable as a dual-function treatment facility for combined sewer overflow and dry-weather sanitary sewage.

4. It can provide removal of dissolved pollutants.

Disadvantages.

1. Increased volumes of sludge.

2. Higher energy needs.

3. Higher treatment costs.

4. Full-scale application to combined sewer overflow is recent.

Sources of Information.

1. Swindler-Dressler Co. "Process Design Manual for Carbon Adsorbtion." EPA 17 020 GNR. October 1971.

2. Shuckrow, A. J., Dawson, G. W. and Bonner, W. F. "Physical-Chemical Treatment of Combined and Municipal Sewage." EPA-R2-73-149. February 1973.

3. Weber, W. J., Jr. Physicochemical Processes for Water Quality Control. Wiley-Interscience. 1972.

Biological Treatment

Process Description. The major objective of biological treatment is to remove the nonsettleable colloidal and dissolved organic matter by biologically converting them into cell tissue which can be removed by gravity settling. Several biological processes have been applied to combined sewer overflow treatment including contact stablization, trickling filters, rotating biological contactors, and treatment lagoons. Biological treatment processes are generally categorized as secondary treatment processes. These processes are capable of removing between 70% and 95% of the BOD_5 and suspended solids from waste flows at dry-weather flow rates and loadings. An operational problem when treating intermittent wet-weather storm events by biological processes is maintaining a viable biomass. Biological systems are extremely susceptible to overloaded conditions and shock loads when compared to physical treatment processes with the possible exception of rotating biological contactors. This and the high initial capital costs are serious drawbacks for using biological systems to treat intermittent combined sewer overflow unless they are designed as a dual treatment facility. Therefore, biological treatment of combined sewer overflow is generally viable only in integrated wet/dry-weather treatment facilities. Biological treatment of combined sewer overflow was demonstrated in Kenosha, Wisconsin, Milwaukee, Wisconsin, and New Providence, New Jersey.

Advantages.

1. Biological treatment processes are well established and familiar to design engineers and operators.

2. High process removal efficiencies are possible.

3. Integration of wet- and dry-weather into dual treatment facilities may be achieved.

Disadvantages.

1. Limited ability of biological processes to handle fluctuating flow rates and pollutant loads.
2. Storage/detention facilities preceding the biological processes are required.
3. Enclosed facilities are necessary in cold climates.
4. High initial capital costs unless integrated as a dual use facility for treating both wet- and dry-weather flows.

Sources of Information.

1. Agnew, R. W. et al. "Biological Treatment of Combined Sewer Overflow at Kenosha, Wisconsin." EPA-670/2-75-019. April 1975.
2. Welsh, F. L. and Stucky, D. J. "Combined Sewer Overflow Treatment by the Rotating Biological Contactor Process." EPA-670/2-74-050. June 1974.
3. Hamack, P. et al. "Utilization of Trickling Filters for Dual-Treatment of Dry- and Wet-Weather Flows." EPA-670/2-73-071. September 1973.
4. Parks, J. W. et al. "An Evaluation of Three Combined Sewer Overflow Treatment Alternatives." EPA-670/2-74-079. December 1974.
5. Metcalf and Eddy, Inc. Wastewater Engineering. McGraw-Hill, 1972.

Disinfection

Process Description. The major objective of disinfection is to control pathogens and other microorganisms in receiving waters. The disinfection agents commonly used in combined sewer overflow treatment are chlorine, calcium or sodium hypochlorite, chlorine dioxide, and ozone. They are all oxidizing agents, are corrosive to equipment, and are highly toxic to both microorganisms and people. Physical methods and other chemical agents have not had wide usage because of excessive costs or operational problems. The choice of a disinfecting agent will depend upon the unique characteristics of each agent, such as stability, chemical reactions with phenols and ammonia, disinfecting residual, and health hazards. Adequate mixing must be provided to force disinfectant contact with the maximum number of microorganisms. Mixing can be accomplished by mechanical flash mixers at the point of disinfectant addition and at intermittent points, by specially designed contact chambers, or both. Chlorine may enhance aftergrowth of microorganisms in the receiving water by cleaving large protein molecules into small proteins, peptides, and other amino acids. Disinfection of combined sewer overflow is included at many locations including Boston, Massachusetts, from 1971 to present, Rochester, New York, from 1975 to present, and Syracuse, New York, from 1974 to present.

Advantages.

1. Water contact and shellfishing of receiving waters is possible with the disinfection of combined sewer overflow.

2. Contamination of public water supplies with pathogenic organisms is reduced.

Disadvantages.

1. Disinfection residuals may be toxic.

2. Disinfection may enhance microorganism aftergrowth in a receiving water.

3. Direct measurement of pathogenic organisms is difficult and may result in a gross overdesign or underdesign of disinfection facilities for intermittent and changing combined sewer overflow characteristics.

Sources of Information.

1. Olivieri, V. P., et al. "Microorganisms in Urban Stormwater." EPA-600/2-77-087. July 1977.

2. Moffa, P. E., et al. "Bench-Scale High-Rate Disinfection of Combined Sewer Overflow with Chlorine and Chlorine Dioxide." EPA-670/2-75-021. April 1975.

3. Weber, J. F. "Demonstration of Interim Techniques for Reclamation of Polluted Beachwater." EPA-600/2-76-228. 1976.

4. Pontius, U. R. et al. "Hypochlorination of Polluted Stormwater Pumpage at New Orleans." EPA-670/2-73-067. September 1973.

5. Maher, M. B. "Microstraining and Disinfection of Combined Sewer Overflow--Phase III." EPA-670/2-74-049. August 1974.

SLUDGE DISPOSAL

As with all treatment processes, the concentrated waste residue generated by combined sewer overflow treatment must be disposed of properly. An EPA report entitled "Handling and Disposal of Sludges from Combined Sewer Overflow Treatment, Phase II--Impact Assessment," EPA-600/2-77-0536, December 1977, presents the results of a study completed in February 1976 which assessed the impact of sludge volumes generated by full-scale treatment of CSO in the United States.

It is estimated that treatment of CSO will generate 41.5 billion gallons of sludge per year, which is approximately 2.6 times the volume of raw primary wastewater treatment plant sludge. However, the average solids concentration in CSO sludge is about 1% compared to 2% to 7% in raw primary sludge. This is due to the high volume, low solids residuals generated by treatment processes employing screens. CSO residuals have a high grit and low volatile solids content when compared to raw primary sludge. Regarding the effect of toxic materials in combined sewage sludges affecting its suitability for application on agricultural lands, an EPA report entitled "Municipal Sludge Management: Environmental Factors," EPA 430/9-77-004, October 1977 presents total amount in pounds per acre of sludge metals allowed on agricultural land for lead, zinc, copper, nickel, and cadmium. These amounts cannot be exceeded for sludges from either separate sanitary or combined sewer areas.

Preliminary economic evaluation indicated that lime stabilization, storage, gravity thickening, and land application is the most cost-effective disposal system. Costs for overall CSO sludge handling depend on the type of CSO treatment process, and volume and characteristics of the sludge, and the size of the CSO area, among other considerations. Estimates indicate that first investment capital costs range from $181 to $4,129 per acre and annual operating costs range from $56 to $660 per acre. The report recommends that the use of grit removal, lime stabilization, and gravity thickening plus dewatering be further investigated to establish specific design criteria for CSO sludge disposal.

☆ U.S. GOVERNMENT PRINTING OFFICE 1978—677-384